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THE

ART

OF MAKING

COMMON SALT.

THE ART OF MAKING COMMON SALT,

As now Practiſed in

Moſt Parts of the World;

WITH SEVERAL

IMPROVEMENTS

PROPOSED in that ART,

For the USE of the

BRITISH DOMINIONS.

BY

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PREFACE.

IT is an old remark, that *all arts and ſciences have a mutual dependance upon each other*. The philoſopher borrows many experiments from the mechanic, which aſſiſt him in his ſearches into nature; the mechanic avails himſelf of the diſcoveries of the philoſopher, and applies them to the uſes of mankind. Thus men, very different in genius and purſuits, become mutually ſúbſervi-

ent to each other; and a very uſe-ful kind of commerce is eſtabliſhed, by which the old arts are improved, and new ones daily invented, and the knowledge of nature is continually advanced, and brought nearer to perfection. Thoſe trades therefore and occupations of life, which formerly brought honour to their inventors, ought not now to be treated with contempt, becauſe grown vulgar and common; but rather, for their general uſefulneſs, ſhould be held in the greater eſteem; and in a particular manner they demand the regard of philoſophers, who have been taught by the noble Verulam, that *the * hiſtory of mechanic arts is a neceſſary part of that knowledge, upon*

* Verulam *De augment. ſcient.* Lib. ii. c. 2.

which

which alone, as on a firm baſis, can be built that true ſcience of nature, which is not taken up in vain and fruitleſs ſpeculations, but effectually labours to relieve the neceſſities of human life.

AMONGST theſe vulgar arts, that of making ſalt, or *of preparing and fitting it for the uſes of mankind*, hath been thought worthy the notice of many great and learned men, as well amongſt the antient as moderns. Thus, many things relating to this art are recorded by *Cato*, and *Pliny* the Naturaliſt. And, if we ſearch the writings of the moderns, we ſhall find the improvements in this art carefully collected by *George Agricola*, *Frederick Hoffman*, *and many other excellent phyſicians*; to which body

of men we are chiefly indebted for thoſe memoirs, that have been tranſmitted to us, relating to its hiſtory. Had thoſe great men been as diligent in improving this art, as they were in recording the improvements made in it by others, there would not now have been occaſion to remark, that, after the practice of ſo many ages, *an art ſo ſimple, and withal ſo neceſſary, hath not yet been brought to any great degree of perfection.*

THAT this art was capable of great improvements, eſpecially as practiſed in Britain, was the ſentiment of the *Royal Society* ſoon after its inſtitution; at which time that renowned body was very intent upon bringing it to greater perfection; as may be gathered

ed from the inquiries and suggestions of Dr. Beal, and the histories of several methods of making salt, which then were published by that Society. And although the English have, since that time, considerably improved their methods of boiling salt; yet *this art is still practised with greater skill and success by their allies the Dutch*; as the superior goodness of the fish, cured with their salt, doth sufficiently prove.

THAT august body *the Commons of Great Britain*, having therefore taken into consideration the great importance of this art, judged some improvements proposed therein worthy of its regard and encouragement; well knowing, that *could this be brought to the*

the ſame perfection in Britain, as in ſome neighbouring countries, large ſums of money might be ſaved in the nation, which are now annually paid to the French and other foreigners; its fiſheries might be greatly improved; and its navies and commerce, and many of its richeſt colonies would no longer depend upon its enemies for one of thoſe neceſſaries, without which they cannot be ſupported.

These conſiderations have induced me to give a brief account of the various methods of making ſalt which now are uſed in Great Britain, and in other countries where this art is practiſed with more ſucceſs; and alſo to attempt ſeveral further improvements in this art for the uſe

uſe of the Britiſh dominions. How far I have ſucceeded in theſe attempts will beſt appear, if the public ſhall think the following propoſals ſo far worthy of their attention as to merit a fair and impartial trial. The principal concluſions, deduced from a variety of obſervations and experiments, are as follows. Firſt, *That by the methods here propoſed, an excellent bay ſalt may be made in Britain, in very large quantities, ſo as to be afforded cheaper than at the prices paid for foreign ſalt; and that the Britiſh colonies in America may very commodiouſly be ſupplied with bay ſalt of their own manufacture, without having recourſe for it to the French, Spaniards, and Portugueze.* Secondly, *That, by the methods here propoſed, an excellent kind of refined white*

white ſalt may be made in Britain, as well from ſea water, and rock ſalt, as from natural brine, in any quantity wanted, ſo as to be afforded cheaper than foreign bay ſalt; and which will alſo be better than common bay ſalt for curing fiſh, fleſh, and other proviſions.

In forming theſe concluſions, I have had an impartial regard to truth, and to the utility of the public, without attending to the private advantages of any particular ſet of men. Some things perhaps may here be offered which have eſcaped the notice of others. The ſenſe of this, together with a deſire of promoting the public advantage, have induced me to communicate the following ſheets. And I rather

rather choſe, at this time, to ſubmit them to the candour of the reader, defective as they are, than by deferring the publication with a view of making them more accurate, to let ſlip the preſent occaſion; which indeed ſeemed the moſt favourable for attempts of this kind, as the nation is at preſent engaged in war with ſeveral potent enemies, from whom it hath heretofore been chiefly ſupplied with this commodity. And more eſpecially as by the late acquiſition of *Cape Breton*, an opportunity is offered of extending the *Britiſh fiſheries*, towards which there ſeems a laudable zeal in the nation; wherein an opinion hath alſo prevailed, that *the eſtabliſhing of fiſheries in the North of Scotland* would be the beſt means of

affording

affording an uſeful employment to the more uncivilized inhabitants of that part of the kingdom; for carrying on of which they are moſt commodiouſly ſituated.

WHAT Mr. Lowndes hath lately done towards the improvement of brine ſalt, may, perhaps, by ſome, be thought to ſuperſede the neceſſity of any further attempts *for improving and extending our ſalt manufacture.* I am very far from deſiring to depreciate the endeavours of that gentleman, which have met with parliamentary encouragement; and had his diſcoveries appeared to me ſufficiently complete and extenſive, I ſhould not have given the public and myſelf this trouble. I make no doubt but that the

ſpecimen of ſalt, which he exhibited before the College of Phyſicians, was *a ſtrong and pure ſalt*, ſince ſuch it appeared to that moſt learned body. Whether the *allum mixed with it* (agreeable to the ancient practice of the Cheſhire ſalt boilers) contributed any thing to its goodneſs, will be more properly conſidered in another place. It is only neceſſary here to obſerve, in *juſtification of the preſent undertaking*, that Mr. Lowndes's method of making ſalt for curing proviſions, doth not appear to be *the beſt* that may be put in practice; ſince I hope to ſhew, that by other methods *a purer and ſtronger ſalt may be made, and at a leſs expence. Neither* is his method ſo *general* and *extenſive* as ſeems to be required

for

for the public good; since Mr. Lowndes confines it almost entirely to boiled brine salt; and hath given no directions concerning the preparation of bay salt. He indeed proposes to meliorate the British sea salt, but seems to despair of preparing a salt either from sea water, or the English rock-salt, fit for the uses of the navy or fisheries; although the Dutch salt, which is the strongest and purest boiled salt now made, is entirely a marine salt, and even the brine, of which Mr. Lowndes makes his salt, is only a solution of the English rock-salt, often in very impure water, as is well known to naturalists.

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INTRODUCTION.

Of SALT in general.

THE ſalt, which we uſe as a ſeaſoning to our food, is, of all ſalts, the moſt excellent[1], and alſo the moſt common. It hath pleaſed the author of nature to provide mankind with ample ſtores of this moſt uſeful and neceſſary commodity. There are few countries which do not afford vaſt quantities of rock or foſſil ſalt. [2]Mines of it have long been diſcovered and wrought in England, Spain, Italy, Germany, Hungary, Poland, and other countries of Europe. In ſeveral parts of the world, there

[1] The ſuperior excellency of common ſalt, appears from its extraordinary uſes to mankind in their food, its admirable effects upon metals, and many other properties.

[2] Amongſt the ſalt mines of chief note are thoſe of Northwich in Cheſhire, Altomonte in Calabria, Hall in Tyrol, Cardona in Catalonia: alſo thoſe ſtupendous mines at Wilizka in Poland, and Soówár in Upper Hungary; of which ſee accounts in *Phil. Tranſ.* N°. 61 and 413.

are huge mountains which wholly conſiſt of foſſil ſalt. [3] Of this kind are two mountains in Ruſſia nigh Aſtracan; ſeveral in the kingdoms of Tunis and Algiers in Africa; and ſeveral alſo in Aſia; and the whole iſland of Ormus in the Perſian gulph almoſt entirely conſiſts of foſſil ſalt [4]. The new world alſo is ſtored with treaſures of this uſeful mine-

[3] The reverend and learned Dr. Shaw gives us the following account of the ſalt of ome mountains in Algiers. "Jibbel Had-deffa is an entire mountain of "ſalt, ſituated near the eaſtern extremity of the lake "of Marks. The ſalt of it is of a quite different quality "and appearance from that of the ſalinæ, being as hard "and ſolid as ſtone, and of a reddiſh or purple colour. "Yet what is waſhed down from theſe precipices by "the dews, attaineth another colour, becoming as white "as ſnow, and loſing that ſhare of bitterneſs which "is in the parent rock ſalt. The ſalt of the mountains "near Lwotaiah and Jibbel Miniſs is of a grey or "blueiſh colour, and, without ſubmitting to the like "accidental purification as at Had-deffa, is very agree-"able to the palate; the firſt eſpecially, being ſold at "Algiers for a penny the ounce." See his *Travels*, p. 229.

[4] "Sunt et montes nativi ſalis, ut in Indis Oromenus, "in qua lapicidinarum modo cæditur, renaſcens: ma-"juſque regum vectigal ex eo eſt, quam ex auro atque "margaritis. Effoditur et e terrâ, ut palam eſt, hu-"more denſato, in Cappadocia. Ibi quidem cæditur "ſpecularium lapidum modo. Pondus magnum glebis, "quas micas vulgus appellat. Carrhis Arabiæ oppido "muros domoſque maſſis ſalis faciunt, aqua ferruminan-"tes." Ita *Plinius Nat. Hiſt.* lib. xxxi. c. 7.

ral,

ral, as well as with all other kinds of ſubterranean productions[5].

Moreover, the ſea affords ſuch vaſt plenty of common ſalt, that all mankind might thence be ſupplied with quantities ſufficient for their occaſions.

There are alſo innumerable ſprings, ponds, lakes, and rivers, impregnated with common ſalt, from which the inhabitants of many countries are plentifully ſupplied therewith.

In ſome countries, which are remote from the ſea, and have little commerce, and which are not bleſſed with mines of ſalt, or ſalt waters; the neceſſities of the inhabitants

[5] "In theſe parts [of Peru] is alſo found great "abundance of the mine or rock ſalt, which is maſſy "and tranſparent, looking like the pureſt cryſtal. Julloma hath in it plentiful veins of this kind of ſalt. "Many years ago the inhabitants of Curagnara de Carangas have enriched themſelves by digging of rock "ſalt; and of late years they have diſcovered veins of "it near the river of Langacollo. But the ſalt mines "of Yocalla, which God hath created near unto the "rich mountain and city of Potoſi, that nothing might "be wanting that was neceſſary for the working of its "ore, yield ſuch abundance of ſalt as is incredible; "whereof is daily ſpent in the working of metals at the "leaſt fifteen hundred quintals, and this conſumption "hath laſted for many years." Alonſo Barba, *Treatiſe of metals, mines, &c.* Chap. vii.

have forced them to invent a method of extracting their common ſalt from the aſhes of vegetables [6].

[6] The muriatic ſalt of vegetables was deſcribed by Dr. Grew under the title of lixiviated marine ſalt. Leewenhoeck obtained cubical cryſtals of this ſalt from a lixivium of ſoda or kelp, and alſo from a ſolution of the lixivial ſalt of Carduus benedictus; of which he hath given figures in a letter to the Royal Society, publiſhed in N°. 173 of their *Tranſactions*. Dr. Dagner, in *Act. Acad. N. C.* vol. v. obſ. 150. takes notice of great quantities of it which he found mixed in pot-aſhes. And the ingenious Dr. Fothergill extracted plenty of it from the aſhes of fern. See *Medical Eſſays*, vol. v. article xiii.

The muriatic ſalt which the excellent Mr. Boyle extracted from ſandiver, and ſuppoſed to be produced from the materials uſed in making glaſs, was doubtleſs ſeparated from the kelp made uſe of in that proceſs. See his *Works abbr. by Dr. Shaw*, vol. iii. p. 376. Kunkel alſo informs us, *Obſ. Chem. poſt.* p. 136. that he took an alcaline ſalt, and after calcining it with a moderate fire, diſſolved it in pure water, and placing the ſolution in a cool cellar, obtained from it many cryſtals of a neutral ſalt. He ſuppoſes that the alcaline ſalt was by the proceſs converted into this neutral ſalt. But 'tis more reaſonable to believe, that the alcaline ſalt which he applied was not pure, but mixed with the muriatic ſalt of vegetables, which by this proceſs was only ſeparated from it.

'Tis doubtleſs chiefly this muriatic ſalt, which, in ſome of the inland parts of Aſia, they extract from the aſhes of duck-weed, and of Adam's fig-tree, and uſe for their common ſalt. An obſcure deſcription how this ſalt is made in the kingdom of Aſem, may be ſeen in Monſieur Tavernier's *Voyages*, Part II. book ii. chap. xvii.

In

In ſhort, this ſalt is diſperſed over all nature; it is treaſured up in the bowels of the earth; it impregnates the ocean; it deſcends in rains[7]; it fertilizes the ſoil; it ariſes in vegetables; and from them is con-

That they are able in thoſe countries to make common ſalt to profit from vegetables, ought not to be wondered at, ſince I have been aſſured by a gentleman of great worth, who had the beſt opportunies of of informing himſelf, that at Dehli and Agra, capitals of Indoſtan, ſalt is ſo ſcarce as uſually to be ſold for half a crown a pound. We may therefore give ſome credit to Marco Polo, when he informs us, that in the inner parts of the ſame quarter of the world, in the province of Caindu, lying weſt of Tebeth, the natives uſed ſalt inſtead of money, it being firſt made up in cakes and ſealed with the ſtamp of their prince; and that they made great profit of this money by exchanging it with the neighbouring nations for gold and muſk. We are alſo told by Ludolfus, in his *Hiſtoria Æthiopica*, that in the country of the Abiſſines there are mountains of ſalt, the which when dug out is ſoft, but ſoon grows hard; and that this ſalt ſerves them inſtead of money to buy all things. The ſame is confirmed by Ramuſio. See his *Voyages into Æthiopia*, chap. 39 and 52.

[7] Mr. Boyle, in his treatiſe on the ſaltneſs of the ſea, takes notice that not only rain water, but alſo ſnow water is very frequently impregnated with ſea ſalt. — In a violent ſtorm which happened in November 1703, the rain which fell in ſeveral parts of Suſſex was ſtrongly impregnated with common ſalt; and Mr. Leewenhoek, at Delft in Holland, obſerved many cryſtals of that ſalt left by the rain, which daſhed againſt his windows during the ſaid ſtorm. *Ph. Tranſ.* N°. 289. p. 1530—35.

veyed into animals[8]. So that it may well be eſteemed the univerſal condiment of nature; friendly and beneficent to all creatures endowed with life, whether it be vegetative, or animal.

NATURALISTS, therefore, obſerving the great variety of forms under which this ſalt appears, have thought fit to rank the ſeve-

[8] Mr. Boyle diſcovered common ſalt in human blood and urine. I have obſerved it, not only in human urine, but alſo in that of dogs, horſes, and black cattle. It may eaſily be diſcovered in theſe, and many other liquids impregnated with it, by certain very regular and beautiful ſtarry figures which appear in their ſurfaces after congelation. Theſe figures I firſt obſerved in the great froſt in the year 1739, and may probably have occaſion to give a fuller account of them elſewhere.

The dung of ſuch animals as feed upon graſs or grain, doth alſo contain plenty of common ſalt; as appears from the method of preparing ſal ammoniacum in Egypt. This ſalt, as 'tis well known, is compoſed of a volatile alcali, ſaturated with ſpirit of common ſalt, and is there ſublimed from ſoot. Now as the dung of camels, aſſes, and black cattle is the common fewel of Egypt; whilſt it is burning, the fire ſeparates from it a volatile alcaline ſalt, and alſo the acid fumes of common ſalt; theſe uniting together in the ſoot form a ſal ammoniacum, which is afterwards ſeparated from it by ſublimation.

From this proceſs we alſo learn, that when vegetables are calcined (at leaſt ſuch of them as have undergone putrefaction) all their muriatic ſalt doth not remain in their aſhes; but a conſiderable portion of it is ſeparated into its principles of an acid ſpirit and a fixed alcaline earth.

ral kinds of it under certain general claſſes; diſtinguiſhing it, moſt uſually, into rock or foſſil ſalt, ſea ſalt, and brine or fountain ſalt. To which claſſes, others might be added of thoſe muriatic ſalts which are found in vegetable and animal ſubſtances.

THESE ſeveral kinds of common ſalt often differ from each other in their outward form and appearance, or in ſuch accidental properties as they derive from the heterogeneous ſubſtances with which they are mixed. But when perfectly pure, they have all the ſame qualities; ſo that chemiſts, by the exacteſt inquiries, have not been able to diſcover any eſſential difference between them[9].

[9] "Ut igitur noſtra hac de re innoteſcat ſententia, "hanc interponimus: ſicuti in totâ univerſi hujus compage, una tantum eſt aqua, unus per fermentationem "paratus ſpiritus ardens, unus mercurius, unum volatile "ſal, unum acidum nitroſum ac vitriolicum ſal; ita, "pari ratione unum idemque ſal commune eſt: ſed "quum plures alienæ, terreæ, lapidoſæ, ſulphureæ, cal-"cariæ minerales ac pingues particulæ cum hiſce cor-"poribus connubium ineant, diverſa exinde emergit "eorum indoles; et ſal commune idem ſemper obti-"neret ingenium, ſi quis pingues, terreas, calcareaſque "partes ab illo artificioſè ſegregare noſſet." Hoffman *De ſalinis Hallenſ.* cap. viii.

Dr. Liſter indeed (in his treatiſe *De font. Med. Angliæ*, L. i. c. i. § iii.) takes notice that the cryſtals of ſea ſalt differ ſomewhat in figure from thoſe of fountain and foſſil ſalt; and ſeems to think this a great diſcovery.

Leaving therefore thefe divifions to thofe whom they may concern; it will, for our prefent purpofe, be more proper to diftinguifh common falt after a different manner, into the three following kinds, viz. into rock or native falt, bay falt, and white falt.

By rock falt, or native falt, is underftood all falt dug out of the earth, which hath not undergone any artificial preparation.

Under the title of bay falt may be ranked all kinds of common falt extracted from the water wherein it is diffolved by means of the fun's heat, and the operation of the air. Whether the water, from which it is extracted, be fea water, or natural brine drawn from wells and fprings, or falt water ftagnating in ponds and lakes.

Under the title of white falt, or boiled falt, may be included all kinds of common falt extracted by coction from the water wherein it is diffolved; whether this water be fea water, or the falt water of wells, fountains, lakes, or rivers; or water of any fort impregnated with rock falt, or other kinds of common falt [10].

But others affert that this difference is only accidental and not conftant; proceeding from fome particular circumftances attending the cryftallization.

[10] The following relations extracted from Alonfo Bar-

The first of these kinds of salt is in several countries found so pure, that it serves for most domestic uses, without any previous preparation (triture excepted.) But the English fossil salt is unfit for the uses of the kitchen, until, by solution and coction it is freed from several impurities, and reduced into white salt. The British white salt also is not so proper as several kinds of bay salt for curing fish, and such flesh meats as are intended for sea provisions, or for exportation into hot countries. So that for these purposes we are obliged, either wholly or in part, to use bay salt, which we purchase

ba seem very particular. " In the Lipes—there is a small " lake upon the top of a little hill—in the middle of " which lake the water boils and leaps up, sometimes " more, sometimes less; making a frightful noise. Out " of curiosity I went to see it, and found the noise and " motion of it so terrible, that with reason there be " very few that dare come near the mouth of it. The " water is thick to that degree, that it looks more like " dirt than water. There is one small gutter where it " runs over; and the water that issueth forth becomes " red salt as it runs along in little channels. This " is a mighty strong salt, and has twice the virtue of " common salt in the working of metals. It hath also " been found to be an excellent remedy for the dysentery; perchance it hath in it a mixture of the red " alum that gives it both colour and spirit. Hard by " this lake runs a vein of Piedra Judaica, and the " country thereabouts is full of mines of copper."

in France, Spain, and other foreign countries.

The following ſheets were wrote with a deſign to remove theſe inconveniences, by ſhewing how the ſubjects of Great Britain may be ſupplied with ſalt of their own manufacture, fit and ſufficient for all their occaſions. But in order that the methods here propoſed may be better underſtood, and that the reaſonableneſs of them may more fully appear, it will be neceſſary to premiſe a brief account of the ſeveral ways of preparing bay ſalt as well as white ſalt, ſo far

"A league and a half from Julloma, in the province "of Pacages, there be many ſalt ſprings that, as they "guſh out of the ground, in a ſhort time become pure "white ſalt, without the help of any art; and they "increaſe into heaps of ſalt until the winter rains diſ- "ſolve and ſweep them away." N. B. This laſt account is confirmed by Herrera.

'Twould be difficult to determine to which of the claſſes here mentioned thoſe two kinds of ſalt belong. It being uncertain, from the deſcription, whether they are foſſil ſalts, or ſalts boiled by ſubterranean heat, or, laſtly, ſalts coagulated by the heat of the ſun. The firſt kind is a very impure ſalt, ſeeming to contain a large quantity of ferruginous earth, and probably alſo a mineral alcali, as may be conjectured from its effects upon metals. It ſeems to be emitted from a fiery ſpiracle, much reſembling that called La Salſa in the territory of Modena; which, Ramazzini informs us, continually boils with melted bitumen.

as they are come to our knowledge. For from this hiſtory we may form a judgment how far the methods now in uſe are proper, in what deficient, and where erroneous, and how they may be improved. The ſame hiſtory will alſo contain many obſervations and experiments which are required in demonſtrating the propoſitions in the third and fourth parts of this treatiſe.

PART

PART I.

The ART of preparing BAY SALT.

CHAP. I.

Of BAY SALT *in general.*

IN relating what I have been able to collect concerning the ſeveral ways of making ſalt, which now are, or formerly have been in uſe, order requires that the more ſimple methods ſhould firſt be deſcribed, and afterwards thoſe which are more artificial and compounded. It will therefore be proper, in the firſt place, to relate the ſeveral methods of preparing bay ſalt, ſo far as they have come to our notice; and where the ſubject will admit of it, I ſhall draw examples

ples from the practice of thoſe who are employed in preparing that commodity for the uſe of the Britiſh dominions.

Bay ſalt may be divided in general into two kinds. Firſt, bay ſalt drawn from ſea water; as is practiſed in France, Spain, Portugal, and many other countries. Secondly, bay ſalt extracted from ſalt ſprings, ponds, and lakes; as at the Cape de Verd iſlands, in Africa; and at Salt-Tortuga, Turks Iſland, and many other parts of America.

The firſt kind is imported, in large quantities, into Great Britain and Ireland; and our American colonies, and fiſheries, in times of peace, are chiefly ſupplied with the latter; but now in time of war, they have large quantities of bay ſalt from Liſbon, and other parts of Portugal.

CHAP. II.

Of bay ſalt extracted by a total exhalation of the water wherein it was diſſolved.

Bay ſalt is prepared in a manner the moſt ſimple and eaſy, when the water of ponds and lakes impregnated with ſalt is totally exhaled, by the force of the ſun

and air, and the ſalt is left concreted into a hard cruſt, at the bottom of the lake or pond.

Of ſalt thus prepared we have many inſtances in ſeveral parts of the world [1]. Thus, "In the Podelian deſert near the river Boryſthenes is a ſalt lake, whoſe water, by "the heat of the ſun, is waſted, and turned to ſalt, like unto ice; ſo that the "people ride into it with horſes and waggons, and cut it into pieces, and carry it "away [2]." I was alſo informed by a worthy friend [3], who long ſerved as a phyſician in the Ruſſian armies, that in the ſame part of the world, viz. on the Ruſſian frontiers towards Crim Tartary, he had,

[1] "Siccatur in lacu Tarentino æſtivis ſolibus, to- "tumque ſtagnum in ſalem abit, modicum alioquin, "altitudine genua non excedens. Item in Sicilia in "lacu, qui Conanicus vocatur, et alio juxta Gelam. "Horum extremitates tantum inareſcunt; ſicut in "Phrygia, Cappadocia, Aſpendi, ubi largius coquitur, "et uſque ad medium lacum." Plin. *Natur. Hiſt.* Lib. xxxi. c. vii.

[2] This account is extracted from the Poliſh hiſtorian Cromerus. See *Phil. Tranſactions abr. by Lowthorp*, vol. ii. p. 525.

[3] Dr. Thomas Humphrey, who was phyſician to the army under Field Marſhal Lacy, in the laſt expedition of the Ruſſians againſt Crim Tartary, where he died of a contagious diſtemper.

in the ſummer ſeaſon, travelled over vaſt deſert plains, where grew neither tree nor herb, and which, for many miles together, were covered over with ſalt [4].

WE are told of a ſalina of this kind in the Weſt Indies, called Garci Mendoza, forty leagues long, and ſixteen broad [5]. But the learned Doctor Shaw hath given us the moſt accurate deſcription of ſeveral of theſe ſalines in the kingdom of Algiers [6], which

[4] The Valley of ſalt mentioned in ſacred Scripture, where David ſmote the Syrians, and ſlew 18,00 of them, is ſuppoſed to be that nigh Tadmor: another of the ſame kind there is nigh Aleppo. *Ph. Tr.* N°. 27.

[5] "The ſalt pits called Garci Mendoza, are none of "the moſt inconſiderable wonders of this new world. "Thoſe pits are called Garci Mendoza, for their big-"neſs, becauſe they be forty leagues long, and, where "narroweſt, ſixteen broad. And alſo becauſe that "ſometimes in the middle of that ſpace are diſco-"vered as it were wells that have no bottom, and "great overgrown fiſhes are ſeen in them. It is very "dangerous travelling over this ſpace of ground, for "fear of loſing one's eye-ſight; becauſe the great "gliſtering of the ſun beams upon that place of "cryſtal, puts out one's eyes, unleſs they be defend-"ed with black tiffany. There is danger of life, "alſo, in that journey: it having happened, that going "over that place, the traveller and his horſe have both "been ſwallowed up, leaving no manner of mark "behind either of them." *Alonſo Barba.*

[6] "The ſalt pits of Arzew lye ſurrounded with "mountains, taking up an area of about ſix miles in

in winter are ſalt lakes, but dry plains in ſummer; at which ſeaſon large quantities of ſalt are dug out of them for ſale. Salinas of the ſame kind have been taken notice of by travellers, in many other parts of the world; but theſe already mentioned are ſufficient for our preſent purpoſe.

CHAP. III.

Of bay ſalt drawn from the brine of ponds and lakes and firſt of ſalt thus prepared; in the Cape de Verd iſlands.

ALthough the Engliſh have, for a long time, prepared vaſt quantities of bay ſalt in the Cape de Verd iſlands; yet no one

" compaſs. They appear like a large lake in winter, " but are dry in the ſummer, the water being then ex- " haled, and the ſalts left behind cryſtallized. In dig- " ging they paſs through different layers of this ſalt, " whereof ſome are an inch, others more in thickneſs, in " proportion, I preſume, to the ſaline particles the wa- " ter was impregnated with, before their reſpective " concretions. This whole area is made up of a " ſucceſſion of ſuch ſimilar ſtrata heaped one upon " another: and in the ſame manner are the ſalinæ " betwixt Carthage and the Guletta, thoſe of the Shott, " and of other places, either bordering upon, or lying " within the Sahara." Dr. Shaw's *Travels*, p. 229.

" Of the like quality and flavour is the ſalt of " the lake of Marks, and other leſſer plains of the

hath

hath hitherto given ſo exact and clear an account of the method of preparing it there, as the nature of the ſubject doth ſeem to require. The following account was collected chiefly from the relations of ſeveral perſons of credit, who themſelves aſſiſted in making ſalt at thoſe iſlands.

THE Cape de Verd iſles which afford ſalt, are chiefly Mayo, Bonaviſta, and Sall. The ſubjects of Great Britain have enjoyed the privilege of making ſalt, at certain ſalinæ in the two firſt mentioned iſlands, excluſive of all other nations, ever ſince the marriage of king Charles the Second with the Infanta of Portugal. They do not pay any acknowledgment to the king of Portu-

" ſame nature. Theſe are uſually called Sibkah, or " Shibkah, *i. e.* ſaltiſh plats of ground; being commonly overflowed in winter (at which time they appear like ſo many extenſive lakes) but dry all ſummer, when they may be taken for ſo many bowling greens, prepared for the turf. Some of theſe " Shibkahs have a hard and ſolid bottom, without " the leaſt mixture of gritty mould, retaining the ſalt " that lyeth cryſtallized upon them after rain. But others " are of a more oozy abſorbent nature, ſeldom preſerving any ſaline incruſtations upon the ſurface. The " chief ſubſtratum of the Shibkah El Low-diah is, " like a teſſelated pavement, made up of various little " cubes of common ſalt." *Id.* p. 230.

gal for this privilege; only, of late years, he hath impoſed a tax, paid by the Britiſh captains for every aſs which they hire of the inhabitants to carry the ſalt to their boats. The time of making the ſalt, is in the dry ſeaſon of the year; which, in thoſe iſlands, is uſually from the latter end of November, to the beginning of July. Thoſe, therefore, who would load with ſalt, endeavour to be there in the month of December, or January. On the weſt ſide of Mayo, or May, they bring their ſhips to anchor in a pretty good road, at a hundred or two hundred yards diſtance from the ſhore. As ſoon as they are on ſhore, they find themſelves upon a bank of light looſe ſand, fifty or ſixty yards broad. And when they have paſſed this bank, they enter upon the ſalina, or ſalt marſh; which lies between the ſand bank, and ſome ſmall hills beyond it. This ſalina is a plain, about half a mile broad and a mile long, the greateſt part of which is hollowed out in ſalt pits, filled at the proper ſeaſon of the year with a ſtrong brine, or pickle (as the ſailors term it) to the depth of about eight inches.

Several writers aſſert, that this brine is only ſea water, which flows through a hole

hole in the ſand bank, like a ſluice, and that, only at ſpring tides. Thoſe that I have converſed with, who made ſalt there, could give no certain information in this particular, only ſaid they had never ſeen any ſuch ſluice, but had obſerved more brine in the ſalt pits at ſpring tides, than at other times. But, as it is certain that there are ſeveral ſalt ponds in Bonaviſta and Sall, which have no communication with the ſea; and that all the ſprings nigh the ſalina in the iſle of May have a brackiſh taſte, and are impregnated with ſalt; and that the brine in the pits is much ſtronger than ſea water; and that it is weakeſt in the pits which are fartheſt from the ſea, growing ſtronger as it falls by a gentle deſcent into the pits which are nigher the ſhore; theſe and other reaſons ſeem to prove, that this ſtrong brine does not proceed from the ſea, but ſprings from the hills adjoining to the ſalt marſh. And this may poſſibly be the caſe, although it ſhould be true, that the brine ſtands higher in the pits at ſpring tides, than at other times. For the ſea water, although it may not flow into the pits at ſpring tides, may notwithſtanding at ſuch times riſe ſo high, as to prevent the brine from draining out of them through the

ſand; and may have the ſame effect with a dam, and ſo cauſe the brine to ſtand higher in the pits at ſpring tides, than at other times [1].

HOWEVER this be, it is certain that at the proper ſeaſon of the year, the ſailors commonly find all theſe pits filled with a very ſtrong brine, or pickle; but ſometimes, after long droughts, they find it more ſcarce, and then dig little wells, from which they fill

[1] An inſtance of the ſame kind I have obſerved in ſome wells, ſunk nigh the ſea ſhore, which commonly afford plenty of freſh water; but in very dry ſeaſons, have only held water when the tide was in, and were empty when the tide was out. The ſprings which ſupply theſe wells, run through a large bed of gravel, out of which the water flows, between the full ſea and low-water mark. When, therefore, the ſaid ſtratum of gravel is quite filled with water, there is conſtantly plenty of it in the wells; but in great droughts, when the ſprings are low, all the water in the ſaid ſtratum runs beneath the bottoms of the wells, and ſprings out on the ſea ſhore, a little above the low-water mark; except at ſuch times as the tide is in; for then, the ſea water has the effect of a dam, and retains the freſh water in the ſtratum of gravel, till it riſes higher than the bottoms of the wells; which are therefore ſupplied with water; until the ſea returning back, gives it liberty again to ſpring out on the ſhore. The colliers alſo in ſinking a coal pit nigh Whitehaven, about fifty or ſixty yards from the ſea ſhore, when they had ſunk to the level of the ſea, obſerved the water at the bottom of the pit, to ebb and flow conſtantly with the tide.

their

their ſalt pits to the depth of eight inches. The bottom of theſe pits is a kind of oozy mud that retains the brine. The ſailors make them of various forms and ſizes, according to their fancy. Thoſe who firſt arrive cleanſe out as many of theſe pits from mud and dirt, as they have occaſion for; the next ſhip's company do the ſame, and ſo ſucceſſively, till all the pits are taken up; and if any more ſhips arrive, they are obliged to wait until thoſe who have poſſeſſion of the pits are ſerved. As the freſh water exhales from the pits, the ſalt forms into cryſtals, which ſink to the bottom of the brine. Twice a week they draw the ſalt out of the pits with rakes into little heaps: and after the brine is ſomewhat drained from it, they put it in barrows, and wheel it to their large heap, where it drains further, and ſoon becomes hard and dry, and fit to be put on board their ſhips. The inhabitants of the iſland willingly aſſiſt, for hire, in making the ſalt; and alſo provide aſſes to carry it to the ſea ſide; from whence it is conveyed, by boats, on ſhipboard. And thus, if the weather be favourable, a large ſhip may be loaden with ſalt in a fortnight; and frequently ſooner, when

(as it often happens) the ſailors, on their arrival, find the pits full of concreted ſalt.

But, on the contrary, it ſometimes happens, that the rainy ſeaſon continues longer than uſual; and then, ſhips have been delayed ſeveral months before they could get their loading. At other times the rains have come on very ſoon; or the ſea hath been ſo boiſterous with tornadoes (as it uſually is for a conſiderable time before the rains ſet in) that no ſalt could be ſhipped on board [2]; or by reaſon of tedious paſſages, ſhips have not arrived in due time. And by ſuch accidents, many ſhips have been diſappointed, and forced to leave theſe iſlands without their loading of ſalt [3].

[2] Theſe high winds alſo frequently injure the ſalt, by driving the ſand amongſt it.

[3] This trade might therefore be carried on, with much greater advantage, if there was a Britiſh factory eſtabliſhed in theſe iſlands, whoſe buſineſs it ſhould be to make ſalt during the whole dry ſeaſon, and to ſell it to the Britiſh ſubjects, as cheap (which they well might) or even cheaper, than our ſailors can now make it themſelves; which, as I am informed, is ſeldom at a lower price than ſixpence per buſhel. By this means our veſſels would not be diſappointed of their loading, or detained ſo long as they now are; and the mariners would have nothing to do at theſe iſles, but to ſhip the ſalt on board; which might ſpeedily be done in large lighters, from wharfs provided for that purpoſe.

The

THE ſalt is made exactly in the ſame manner at Bonaviſta as at the iſle of May. The ſalinæ at both iſlands are nearly of the ſame magnitude; that at Bonaviſta alſo lies beyond a ſand-bank, which is about two hundred yards broad. But the brine is there weaker and does not kern[4] ſo faſt as at the iſle of May. And the ſea being there very ſhallow, the ſhips are obliged to ride at anchor at a mile diſtance from the ſhore; ſo that the ſailors have there a good deal of trouble in ſhipping the ſalt. For theſe reaſons our veſſels ſeldom load there, when they can be ſupplied with ſalt at the iſle of May. But although theſe iſles are only about eighteen leagues diſtant from each other, yet the ſailors have found by experience, that the rainy ſeaſons ſometimes begin ſeveral weeks ſooner, or continue longer at one of theſe iſlands, than the other. Sometimes, therefore, when the weather proves unfavourable at the iſle of May, or when there happens to be too great a crowd of ſhips there[5], the ſailors find it more con-

[4] To kern, is a term which the ſailors uſe, ſignifying to corn, or to form into grains, or cryſtals of ſalts. Our ſalt-boilers call it graining, or ſalting.

[5] There are frequently fifteen or ſixteen ſhips loading

venient to load at Bonaviſta. The weather at theſe iſlands is ſeldom exceſſively hot, the heat of the ſun being tempered by freſh breezes from the ſea.

CHAP III. SECT. II.

Of bay ſalt made at Tortugas and other places in America.

OUR American colonies have, for near a century paſt, been ſupplied with large quantities of bay ſalt from Salt Tortuga, one of the Leeward iſlands, uninhabited, ſituated nigh the coaſt of Caraccos on the Spaniſh main [1]; alſo from Turks iſland, which lies not far from Hiſpaniola [2]; and many veſſels freighted from North America

with ſalt at the iſle of May. Some have known fifty ſhips there together.

[1] The Dutch alſo draw large quantities of ſalt from ſome ponds in Bonairy, an iſland belonging to them, not far diſtant from Salt Tortuga.

There are alſo conſiderable quantities of ſalt made in ſeveral of the Caribbee iſlands, particularly at Anguilla, St. Martin's, and St. Chriſtopher's.

[2] Dampier informs us, that there is a pretty good road on the ſouth eaſt ſide of this iſland, and that the ſalina lies adjoining to it, within two hundred paces of the ſea; and that, in peaceable times, he had ſeen above twenty ſail of ſhips in this road at one time, come to load ſalt.

to

to Barbadoes, and others of the Caribbee iſles, were accuſtomed to go from thence to theſe ſalt iſlands, and carry back a loading of ſalt; for which they found a market in New-foundland, New-England, and other Britiſh colonies in North America.

THE Spaniards, for a long time, gave the Britiſh ſubjects no moleſtation in this trade. But, a few years before the preſent war between the two nations broke out, they began to ſeize all Britiſh ſhips laden with ſalt, which they met with nigh their ſettlements, claiming the ſole property of theſe ſalt iſlands. The Britiſh ſubjects, unwilling to loſe ſo valuable a branch of trade, which they had long enjoyed without any interruption, reſolved to maintain themſelves in it by force; therefore went no more in ſingle ſhips, but in large fleets of armed veſſels. Theſe veſſels uſually joined fleet at Barbadoes, or ſome other of the Caribbee iſlands, where ſeventy or eighty ſail of them would ſometimes muſter. Before they ſet forward upon the voyage, they choſe a commodore, who had the chief command, and entered into engagements for their mutual defence; and then ſet ſail, uſually about the beginning of March. They commonly went to Tortu-

ga; where, as ſoon as they arrived, they divided the ſalinæ into ſeveral portions, allotting one for each ſhip, according to its burden. Each ſhip's company then uſed what diligence they could in collecting the ſalt that fell to their ſhare, and wheeling it down to the ſhore, thence carried it in boats on board their ſhip. They commonly found ſalt enough to load the whole fleet; but it ſometimes fell ſhort, either when the fleet was too numerous, or when the ſeaſon proved unfavourable. As ſoon as they had done ſhipping the ſalt, the whole fleet ſet ſail together, and remained united, until they thought themſelves out of danger from the Spaniſh Guarda coſtas; and then each ſhip ſteered towards its intended port.

THE method of making ſalt at Tortuga and Turks iſland is much the ſame as that practiſed in the Cape de Verd iſles; only, in the American iſles, they do not collect it out of ſmall pits, but larger ponds. The ſailors, on their arrival, often find large quantities of fine clear ſalt lying at the bottom of theſe ponds, from whence they rake it out.

MANY have related, as ſomething very extraordinary, that in theſe American iſlands the ſalt kerns, or forms into grains, only dur-

ing

ing the wet ſeaſon of the year. But they are certainly miſtaken who think that any ſalt is formed in theſe iſlands during the continual rains which fall in the wetteſt ſeaſon; or that the brine in the ponds will not let go its ſalt, until it is diluted and made weaker by rains. The truth of the matter is probably this: During the conſtant rains, ſuch vaſt quantities of water fall, that the ſalt lakes overflow, and large quantities of ſalt are waſhed quite away. After the rain ceaſes, the ponds remain filled with a weak brine, ſo that no ſalt can cryſtalize in them till moſt of the water is exhaled; which does not happen till towards the time that the rainy ſeaſon again ſets in. But in the countries lying between the tropics, which have their dry and wet ſeaſons, the rains almoſt conſtantly come on in tornadoes, or thunder ſhowers, which for the firſt month, or ſix weeks, only fall once a day, and ſometimes only once in two or three days; eſpecially in theſe iſlands, which are not ſubject to ſuch long and violent rains as many parts of the continent lying under the ſame degrees of latitude. Theſe tornadoes therefore, waſh much ſalt from the ſurface of the earth into the ponds, and alſo ſupply the ſprings with water,

water, which being impregnated with ſalt in its paſſage through the earth, continually repleniſhes the ponds with brine. But when the weather continues exceſſively dry, theſe ſprings are dried up, and no more brine flows into the ponds. Theſe tornadoes, therefore, do not contribute towards cryſtalizing the ſalt; but only repleniſh the ponds with brine, which is reduced into ſalt by the heat of the ſun. So that whilſt the rains are moderate, and the water ariſes in vapours, as faſt as it falls in dews and ſhowers, large quantities of ſalt are made in the ponds. But as ſoon as the rains become exceſſive, and more water flows into the ponds than is exhaled from them, the brine becomes weak, and no more ſalt is extracted from it.

THIS account agrees well with what captain Dampier hath related concerning the method of making ſalt at the ſalinæ in the bay of Campeachy. His account is as follows.

" [3]THE Salina is a fine ſmall harbour for " barks, but there is not above ſix or ſeven

[3] The ſame author gives the following account of the weather in the bay of Campeachy, which will ſerve to illuſtrate ſeveral particulars here taken notice of.

" The dry ſeaſon begins in September, and holds till " April, or May; then comes in the wet ſeaſon, which

" feet

" feet water. And close by the sea, a lit-
" tle within the land, there is a large salt
" pond belonging to Campeachy town,
" which yields abundance of salt. At the
" time when the salt kerns, which is in May

" begins with tornadoes, first one a day, and by degrees
" increasing till June; and then you have set rains till
" the latter end of August. This swells the rivers so
" that they overflow, and the Savannahs begin to be
" covered with water; and although there may be some
" intermission of dry weather, yet there are still plenti-
" ful showers of rain, so that as the water does not in-
" crease, neither does it decrease, but continues thus
" till the north winds are set in strong, and then all the
" Savannahs, for many miles, seem to be but part of the
" sea. The norths do commonly set in about Octo-
" ber, and continue by intervals till March.—These
" winds blowing right in on land, drive the sea, and
" keep the tides from their constant course as long as
" they last, which is sometimes two or three days; by
" this means the freshes are pent up, and overflow much
" more than before, though there be less rain. They
" blow most fiercely in December and January; but
" afterwards they decrease in strength, and are neither
" so frequent nor lasting; and then the freshes begin
" to drain from off the ground. By the middle of Fe-
" bruary the land is all dry; and in the next month
" perhaps you will scarce get water to drink, even in
" those Savannahs that but six weeks before were like a
" sea. By the beginning of April, the ponds also in
" the Savannahs are all dried up, and one who knows
" not how to get water otherwise may perish for thirst.
" But those who are acquainted here, in their necessity
" make to the woods, and refresh themselves with wa-
" ter that they find in wild pines." Vol. ii. p. 2.

" OF

" or June, the Indians of the country are
" ordered by the Spaniards to give their at-
" tendance, to rake it aſhore, and gather
" it into a great pyramidal heap, broad be-
" low, and ſharp at the top like the ridge
" of a houſe; then covering it all over with
" dry graſs and reeds, they ſet fire to it, and
" this burns the out ſide ſalt to a hard black
" cruſt. The hard cruſt is afterwards a de-
" fence againſt the rains that are now ſet in,
" and preſerves the heap dry, even in the wet-
" teſt ſeaſon[4]. The Indians, whoſe buſineſs
" I have told you, is to gather the ſalt thus
" into heaps, wait here by turns all the kern-
" ing ſeaſon, not leſs than forty or fifty fa-
" milies at a time. — When the kerning
" ſeaſon is over, they march home to their
" ſettled habitations, taking no more care
" about the ſalt. But the Spaniards of Cam-
" peachy, who are owners of the ponds, do
" frequently ſend their barks hither for ſalt
" to load ſhips that lie in Campeachy road;
" and afterwards tranſport it to all the ports
" in the bay of Mexico, eſpecially to Alva-
" rado and Tompeck, two great fiſhing

[4] This method of preſerving ſalt from rains is alſo practiſed in the Cape de Verd iſlands.

" towns,

" towns, and I think that all the inland " towns thereabouts are ſupplied with it."

CHAP. IV.

Of marine bay ſalt prepared in France and other parts of Europe.

THE moſt perfect works of art are generally the trueſt imitations of nature. Hence ſome have thought, that thoſe artificial methods which have been invented for preparing ſalts, and extracting them from water, were borrowed from thoſe more ſimple methods by which men obſerved thoſe ſalts to be ſeparated from their watery vehicle without the help of art [1]. This opinion

[1] "Initio ſolertes homines cum viderent aquas quo" rundam lacuum, natura ſucci plenas, ſolis ardoribus " ſiccatas conſpiſſari, atque ex eis fieri ſuccos concre" tos; veriſimile eſt, eos, aquas aſſimiles aliis in locis " infudiſſe, vel corrivaſſe in areas ad aliquam altitudi" nem depreſſas, ut ipſas etiam ſolis calores condenſarent. " Deinde, quia viderent iſta ratione ſuccos concretos " tantummodo æſtate confici poſſe, nec tamen in om" nibus regionibus, ſed in calidis et temperatis ſolum, " in quibus æſtivo tempore raro pluit; eas quoque in " vaſis igne ſubjecto coquere ad ſpiſſitudinem cœpiſſe: " quo modo omnibus anni temporibus, in omnibus " regionibus, etiam frigidiſſimis, ex aquis ſuccoſis, ſive " natura ſive ars eas infecerit; coctis ſucci concreti " confici poſſunt." Agricola *De re metallicâ*, Lib. xii.

nion ſeems to be countenanced by the great reſemblance that may be obſerved between thoſe plain and ſimple methods of preparing bay ſalt already related, and thoſe more artful methods of preparing it from ſea water, which have long been practiſed in Europe, and which it will be proper in the next place to deſcribe.

Bay ſalt is not extracted from ſea water in the colder parts of Europe; as on the ſea coaſts of Germany, Denmark, and Sweden; but in places ſituated in a more ſouthern climate, where the heat of the ſun is more intenſe, as on the coaſts of France, Spain, and Italy. Some marine bay ſalt hath alſo of late years been made in England, at Lemington, and other parts of Hampſhire, and in the iſle of Wight; but in thoſe places, only in the drier ſummers, and then, rather by accident than deſign; it being collected from certain ponds which were originally made for heightening ſea water, or reducing it into a ſtrong brine by the heat of the ſun, in order to leſſen the expence of fewel in boiling it into white ſalt[z].

[z] In dry ſummer weather conſiderable quantities of bay ſalt may alſo be collected on the Engliſh ſhores in hollows of the rocks, where the ſea-water hath been left by the tide.

THE ponds in which this ſalt is made do nearly reſemble a rude kind of ſalt-marſh deſcribed by Agricola [3], in which the ſea-water is received from a pool into a trench; and from thence derived by ſluices into ſeveral pits dug out of the earth; and when it hath ſtood ſome time in theſe pits, it is let out into others, where it ſtands a certain time according to the heat of the weather; and then is made to flow by ſluices into other pits; till at length, being reduced to a ſtrong brine, it is ſuffered to ſtagnate in pits; where the ſalt cryſtallizing, is from thence at proper times drawn out [4].

BUT the French marſhes, in which immenſe quantities of ſalt are annually prepared, are contrived after a much more artful manner. And as they are the moſt commodious that have hitherto been invented, it may be proper here to tranſcribe an account of them, as given by an ingenious French phyſician, and publiſhed in the *Tranſactions of the Royal Society* [5].

[3] *De re metallica*, Lib. xii.

[4] A deſcription of the Hampſhire works, ſee afterwards in Part ii.

[5] The following is the account publiſhed by Lowthorp in his *Abridgment*, Vol. ii. p. 363. and is almoſt the ſame verbatim with that in the *Tranſactions*, N° 51. p. 1425.

" Plate 1. *A A A.* is the ſea.

" 1.1. The entry by which the ſea water paſſes into *B B.*

" *B B.* The firſt receptable, in which the " water maketh three turnings as you ſee, " and is ten inches deep[6].

" 2.2. The opening, by which the firſt " and ſecond receptacle have communication " one with another[7].

" *E E F.* The third receptacle is properly " called the mariſh.

" *d d d d.* Is a channel very narrow, through " which the water muſt paſs before it enters " out of the ſecond receptacle into the " third.

"3.3. Is the opening, by which the water runs " out of the ſecond into the third receptacle. " The pricks you ſee in the water throughout " the whole ſcheme, do mark the courſe and " turnings which the water is forced to make " before it comes to *h h h h,* which are the " places where the ſalt is made.

only a few particulars are here omited which do not relate to the ſubject.

[6] It is in the ſecond receptacle *C C* that the water makes three turnings.

[7] This opening is more conveniently made in this place than at * where the ſea water in the firſt re-

" *hhhh*. Are the bed of the mariſh where " the ſalt is made, and in them the water " muſt not be above an inch and a half deep. " Each of theſe beds is fifteen foot long, " and fourteen foot large[8].

" 9999. Are the little channels between " the beds.

" 8888. Are the apertures by which the " beds receive the ſea water after many " windings and turnings.

" WHEN it rains the openings 2.2. 3.3. " are ſtopped to hinder the water from run- " ning into the mariſh. Unleſs it rain much, " the rain water doth little hurt to the " mariſh; the heat of the ſun ſufficiently " exhaling it, if it be not above an inch high; " only if it have rained very plentifully that " day, no ſalt is drawn for the three or four " next days. But if it rain five or ſix days, " the people are then neceſſitated to empty " all the water off the beds by a peculiar " channel, which cannot be opened but " when it is low water. But it is very ſel- " dom that it rains ſo long as to conſtrain " men to empty thoſe beds. The hotteſt

ceptacle is ſtrongeſt than (as in the *Ph. Tr.*) at ** which ſeems too nigh the entry of the ſea.

[8] And framed on every ſide with wood.

 " years

" years make the moſt ſalt, and in the hot-
" teſt part of the ſummer there is ſalt made
" even during night. Leſs ſalt in calm than in
" windy weather.

" The weſt and north weſt winds are the
" beſt for this purpoſe.

" Our country people draw the ſalt every
" other day, and every time more than an
" hundred pound weight of ſalt.

" The inſtruments uſed to draw the ſalt
" have many ſmall holes to let the water
" paſs, and to retain nothing but the
" ſalt.

" The reddiſh earth in the mariſhes
" make the ſalt more gray, the blueiſh
" more white. Beſides if you let run in a
" a little more water than you ought, the
" ſalt becomes then more white, but then it
" yields not ſo much. Generally all the
" mariſhes require a fat earth, neither ſpungy
" nor ſandy.

" The ſalt man who draws the ſalt muſt
" be very dextrous. In this iſle of Rhee,
" men there are that draw very dark ſalt,
" and others that draw it as white as ſnow;
" and ſo it is at Xaintonge. Chiefly care is
" to be taken that the earth at the bottom of
" the beds mingle not with the ſalt.

The

" THE ſalt we uſe at our tables is per-
" fectly white, being the cream (or that ſalt
" which is formed on the top of the water)
" drawn four or five hours before the ſalt is
" to be drawn. The grains of it are ſmal-
" ler than of the other. Generally the
" ſalt of Xaintonge is ſomewhat whiter than
" ours. The bigneſs of our ſalt is the ſize
" of a pepper grain, and of a cubical
" ſhape.

" The mariſhes are preſerved from one year
" to another, by overflowing them a foot high.

" THE timber of the mariſhes, if it be of
" good oak, keeps near thirty years; but
" there is uſed but little wood, all the ditches
" and apertures, being done with ſtones."

THE foregoing deſcription being in ſome parts obſcure, and in others imperfect, it is neceſſary to add to it a few remarks by way of explanation; that the conſtruction of the French ſalt-marſh, and the method of preparing ſalt therein may be better underſtood. And this ſeems the more neceſſary, ſince, although the above account of the French method of making ſalt hath long been publiſhed, yet it hath not been brought into uſe, neither in Great Britain nor in the Britiſh colonies in America.

Those therefore, who would make a ſalt marſh, commonly chuſe a low plat of ground adjoining to the ſea, diſtant from the mouths of large rivers, but nigh a convenient harbour for boats or larger veſſels. This ground muſt be free from ſprings of freſh water, and no ways ſubject to land floods; and, if poſſible, ſhould have a clayey bottom; it ſhould alſo be defended from the ſea either by banks of riſing ground, or by an artificial mole raiſed for that purpoſe.

The ground ſo choſen muſt be hollowed out into three ponds or receptacles. The firſt, into which the ſea water is uſually admitted, may be called the reſervoir. The ſecond receptacle (which is divided into three diſtinct ponds, communicating with each other by narrow paſſages, and containing brine of different degrees of ſtrength) may be called the brine ponds. The third receptacle is furniſhed with an enterance, between which and the brine ponds there runs a long, winding, narrow channel; the reſt of it is divided into ſeveral ſhallow pits containing a fully ſaturated brine, which in them is converted into ſalt, and may therefore be diſtinguiſhed by the name of the ſalt pits.

The

THE firſt receptacle or reſervoir muſt have a communication with the ſea by a ditch defended on each ſide with walls of brick or ſtone; and made of ſuch a depth that by it all the water contained in the reſervoir and other parts of the ſalt marſh may flow out at low water; and by it alſo the ſea water may be admited into the reſervoir at full ſea; ſo that, at neap tides, the marſh may be filled with ſea water to the depth of ten inches in the reſervoir; and conſequently at higher tides, to the depth of two feet, when there is occaſion to overflow the marſh, as is done in the winter ſeaſon when no ſalt is made; by which means the wood work is longer preſerved from decay, and the bottom of the marſh from froſt and other injuries. And in order that the marſh may be thus overflowed when occaſion requires, it is neceſſary that the ſeveral receptacles ſhould be ſunk ſo deep that the ground on all ſides may be ſufficiently elevated to keep in the ſea water at the depth above mentioned. The ditch between the ſea and the reſervoir muſt alſo be provided with a ſluice or floodgate, by which the ſea water may be admitted, retained, or let out, and

the whole ſalt marſh drained as occaſion may require.

THE ſeveral ponds or receptacles muſt not have their bottoms all upon the ſame level, but muſt be made of unequal depths; ſo that the firſt receptacle or reſervoir muſt be eight inches and a half deeper than the ſalt pits in the third receptacle. The three brine ponds, ſituated between the reſervoir and the ſalt pits muſt alſo be of unequal depths, that adjoining to the reſervoir being the deepeſt, and that, which is nigheſt the ſalt pits, the ſhalloweſt; but all of them muſt be ſhallower than the reſervoir. And the three receptacles being thus conſtructed; the water ſtanding at the ſame height in them all, and forming with its ſurface one continued plain, will be ten inches deep in the reſervoir, when only an inch and a half deep in the ſalt pits.

THE judicious French author hath not given us any account of the length and breadth of the reſervoir and brine ponds, but ſome judgment may be formed of their ſize from his plan of the whole work. It will be better to err by making them too large, than too ſmall. In general, they ought to be large enough to furniſh the ſalt

pits with a conſtant ſupply of brine fully ſaturated with ſalt; and for that purpoſe it is neceſſary to have them of different dimenſions in different countries, as will be hereafter explained.

IT is not neceſſary that the reſervoir ſhould be exactly of the form which the French author hath deſcribed, where the ground will better admit of another, that may be choſen. And even the brine ponds, and ſalt pits may be made of different forms, if due regard be had to the general contrivance of the whole work.

FOR the bottoms of the reſervoir and brine ponds any kind of tough, lean clay, or earth, that will hold water, may ſerve very well. The French make the bottoms of their ſalt pits of any blue or red clay they meet with; but in order to have a white clean ſalt, it is neceſſary that thoſe pits ſhould be carefully laid with ſome ſtrong cement that will retain the brine, and cannot eaſily be broken up. As to other particulars relating to the ſtructure of the French ſalt marſh, they are ſufficiently explained by the ingenious phyſician whoſe account is before inſerted.

THE marſh being thus conſtructed; the ſalt

ſalt men, at the proper ſeaſon of the year, open the floodgate when the tide is out, and drain off all the ſtagnating water; and, if there be occaſion, repair the bottom of the marſh, and cleanſe its ſeveral receptacles from mud and dirt. Afterwards, when the tide riſes, they, by the ſame floodgate admit the ſalt water into the marſh, 'till it ſtands in the reſervoir at the height of ten inches. In a day or two, moſt of the water in the ſalt pits is exhaled, and what remains in them is a very ſtrong brine. They then let in more ſea water; and ſo take care, every two or three tides (oftener or ſeldomer as occaſion requires) to admit as much water into the reſervoir as will ſupply the place of that which hath been waſted in vapours; conſtantly raiſing it to the height of ten inches in the reſervoir; and conſequently, to an inch and an half in the ſalt pits [9]. All the parts of the marſh are thus ſupplied with water out of the reſervoir; but the ſea water, which flows into the reſervoir, is not confuſedly mixed with the ſalter water contained in other parts of the work. For, as the ſe-

[9] When the Weather is exceeding hot, and there are dry winds, the pits ſhould be filled higher, than when the weather is more temperate and the air more moiſt.

veral

veral parts communicate only by narrow paſſages; it is provided. that the ſalt water, flowing out of the reſervoir, never returns there again; but gently flows along till it arrives at the ſecond brine pond, and afterwards at the third; being forced forward by the ſea water, and from time to time received into the reſervoir. During this ſlow courſe, the watery fluid continually flies off in exhalations, and the brine is continually preparing for cryſtallization as it gently flows along, growing ſtronger and ſtronger the nearer it approaches to the ſalt pits. So that when it enters theſe pits, it is fully ſaturated with ſalt. And particular care is taken to guard the entrance of the ſalt pits with a long winding narrow channel; by which means the ſtrong pickle contained in theſe pits is prevented from returning back, and mixing with the weaker brine in the brine ponds. Care is alſo taken that the ſtrong pickle in the ſalt pits be ſpread out very thin to the ſun and air, with a large ſurface; by which means the watery vapours more quickly exhale from it, leaving the ſalt concreted into cryſtals. Theſe the ſalt men carefully draw out, and oftentimes diſpoſe into large pyramidal heaps; which they thatch over

over with ſtraw, and ſo preſerve them from the injuries of the weather. Thus, at a ſmall expence and trouble a ſalt is prepared which is found extremely fit for all domeſtic uſes; and thus France is alſo furniſhed with a very profitable article for exportation into foreign countries.

The French have ſo many works of this kind, that an ingenious author of that nation affirms, that, in favourable ſeaſons, as much ſalt is ſometimes made in a fortnight as is ſufficient for the whole annual conſumption of that kingdom, and of all thoſe other nations who purchaſe much more of it than the French conſume themſelves; but after a rainy ſummer there is often a ſcarcity of ſalt, and the price of it increaſes.

PART

PART II.

The ART of preparing WHITE SALT.

CHAP. I.

Of WHITE SALT *in general.*

ALTHOUGH, in warm climates, ſalt is made, with the greateſt eaſe, and at the leaſt expence, by the heat of the ſun, after the methods already deſcribed; yet, in ſeveral countries, where bay ſalt might be conveniently made, they prepare all their ſalt by culinary fires. Thus in Auſtria, Bavaria, and many other parts of Germany, and alſo in Hungary, and even in

in ſome parts of Italy [1], they conſtantly boil the water of their ſalt ſprings into white ſalt; either becauſe the cuſtom of making ſalt in that manner hath long prevailed, and leſs expenſive methods have not been thought of; or elſe, becauſe in thoſe inland countries, they have no great occaſion for very ſtrong ſalt to cure proviſions, and eſteem white ſalt more beautiful and fitter than bay ſalt for the uſes of the table; or laſtly, becauſe, in thoſe countries, they are unwilling to waſte any of their brine, which could not be converted into ſalt by the heat of the ſun during the winter ſeaſon. But in other parts of Europe, as in Britain, and in the northern parts of France and Germany, an erroneous opinion long prevailed, that the heat of the ſun was not there ſufficiently intenſe, even in the ſummer ſeaſon, to reduce ſea water, or brine into bay ſalt. And all arguments would probably have been inſufficient to remove this prejudice from the Engliſh, had not the

[1] "Tales ſalinæ extant in Volaterrano, ubi collecta "aqua e puteis altiſſimis, et in cortinis plumbeis decocta, "in ſalem paulatim denſatur, qui omnium albiſſimus "ac tenuis, in lautis menſis eligitur: unicum hodie "illi civitati vectigal." Baccius, *De Therm.* L. v. Cap. 4.

contrary

contrary been fully proved by experiments. which were firſt accidentally made in Hampſhire. However, the method of making ſalt by coction will probably ſtill continue to be practiſed in Britain; as the ſalt ſo prepared is for ſeveral uſes preferable to bay ſalt; and when prepared after a particular manner, is preferable to common bay ſalt, even for curing proviſions, as the practice of the Hollanders doth ſufficiently teſtify. So that the due and right preparation of white ſalt ſeems very deſerving of the notice and regard of the public.

WHITE ſalt, as it is prepared from various ſaline liquors, may therefore be diſtinguiſhed into the following kinds[2]. viz.

1. Marine boiled ſalt; which is extracted from ſea water by coction.

[2] Under the heads here given may be included all kinds of white ſalt now in uſe; although other kinds differing at leaſt in preparation from thoſe here mentioned may probably be uſed hereafter; as the refined white ſalt recommended in the fourth part of this work. Other kinds have alſo formerly been in uſe, as ſalt boiled in earthen veſſels by the heat of natural baths, of which George Agricola gives the preparation, Lib. xii. *De re metallica*. Alſo that kind of ſalt ſaid to be made in Lorrain, by caſting ſalt water upon hot plates of iron, as Monſieur Pomet relates, *Hiſtoire des Drogues*, Lib. iii. C. 13.

2. Brine

2. Brine or fountain ſalt, prepared by coction from natural brine whether of ponds and fountains, or of ponds, lakes, and rivers.

3. White ſalt prepared from ſea water, or any other kind of ſalt water, firſt heightened into a ſtrong brine by the heat of the ſun, and the operation of the air.

4. White ſalt prepared from a ſtrong brine or lixivium drawn from earths, ſands, or ſtones impregnated with common ſalt.

A yet more rude method of preparing ſalt was practiſed by the ancient Gauls, Germans, and Spaniards, as Tacitus and others teſtify. The ſalt by them prepared might have ſome pretenſions to the name of a boiled ſalt, although it was not white, but black. Pliny gives the following account of it. "Galliæ, Germaniæque, ardentibus lignis aquam ſalſam infundunt.—Quercus optima, ut quæ per ſe, cinere ſincero, vim ſalis reddat: alibi corylus laudatur; ita, infuſo liquore, carbo etiam in ſalem vertitur. Quocunque ligno confit, ſal niger eſt." *Hiſt. Nat.* L. xxxi. c. 7.

Doctor Beal obſerves, that "in Varro's days, it was "the reproach of our Trans Alpines (who dwelt much "farther towards the ſouth than we do) that on the "Rhine, Nec vitis, nec olea, nec poma naſcerentur; "ubi ſalem nec foſſilem, nec maritimum haberent; "ſed ex quibuſdam lignis combuſtis, carbonibus ſalſis, "pro eo uterentur." Varro, *de re ruſt.* L. i. c. 6. "—The world (remarks that judicious phyſician) is much "amended ſince thoſe days, on this ſide the Alpes. "And the Engliſh may yet be minded to proceed as far "as they can, to remove the reproach, at leaſt for "*fruit*, *wine*, and *ſalt*." *Ph. Tr.* N°. 103, p. 48.

5. Re-

5. REFINED rock ſalt; which is boiled from a ſolution of foſſil ſalt in ſea water, or any other kind of ſalt water, or pure water.

6. LASTLY, ſalt upon ſalt; which is bay ſalt diſſolved in ſea water, or any other ſalt water, and with it boiled into white ſalt.

UNDER theſe heads may be ranked the ſeveral kinds of boiled ſalt now in uſe. It will be proper therefore to treat the preparation of theſe ſeveral kinds of common ſalt, in the ſame order in which they are here enumerated.

CHAP. II. SECT. I.

Of ſalt boiled from ſea water.

THE method of extracting ſalt from ſea water by coction is only practiſed in places where great plenty of fuel can be had at a very low price; and therefore is uſed in few countries except on thoſe parts of the Britiſh coaſts which moſt abound with pit coal, as at North and South Sheilds, Blyth, and other places in Northumberland and Durham[1]; from whence this ſalt is ex-

[1] In theſe two counties they have about two hundred

ported in large quantities, under the name of Newcaſtle ſalt, to London and other parts of England, and to Denmark, Norway, and other northern countries. Much of this ſalt is alſo made on the coaſts of Cumberland; and at ſeveral works ſituated on the Firth of Forth, and at Air and Saltcotes in Scotland; at all which places the worſt of their coals are applied to this uſe.

THE works for making this ſalt are variouſly conſtructed in various places; thoſe ſeem beſt contrived which are made after the following manner.

AT ſome convenient place near the ſea ſhore is erected the ſaltern [2]. This is a long, low building, conſiſting of two parts; one of which is called the fore-houſe, and the other the pan-houſe or boiling houſe. The fore-houſe ſerves to receive the fuel, and cover the workmen; and in the boiling houſe are placed the furnace, and pan in which the ſalt is made. Sometimes they have two pans, one at each end of the ſaltern; and the part appropriated for the fuel and workmen is in the middle.

pans at work, in which they annually prepare eleven or twelve thouſand tons of ſalt.

[2] See Plate II. Fig. 1.

THE

THE furnace [3] opens into the fore-houſe, by two mouths, each of which is a mouth to the aſh pits. To the mouths of the furnace, doors are fitted; and over them a wall is carried up to the roof, which divides the fore-houſe from the boiling-houſe, and prevents the duſt of the coal, and the aſhes and ſmoke of the furnace from falling into the ſalt pan. The fore-houſe communicates with the boiling houſe by a door placed in the wall which divides them.

THE body of the furnace [4] conſiſts of two chambers divided from each other by a brick partition called the mid-feather; which from a broad baſe terminates in a narrow edge nigh the top of the furnace; and by means of ſhort pillars of caſt iron erected upon it, ſupports the bottom of the ſalt pan; it alſo fills up a conſiderable part of the furnace, which otherways would be too large, and would conſume more coals than, by the help of this contrivance, are required. To each chamber of the furnace is fitted a grate, through which the aſhes fall into the aſh

[3] See a repreſentation of the front of the furnace Plate III. Fig. 2.

[4] See Plate III. Fig. 2.

pits[5]. The grates are made of long bars of iron, ſupported underneath by ſtrong croſs bars of the ſame metal. They are not continued to the fartheſt part of the furnace, it being unneceſſary to throw in the fuel ſo far; for the flame is driven from the fire on the grate to the fartheſt part of the furnace; and from thence paſſes together with the ſmoke, through two flues into the chimney[6]; and thus the bottom of the ſalt pan is every where equally heated.

THE ſalt pans[7] are made of an oblong form, flat at the bottom, with the ſides erected at right angles; the length of ſome of theſe pans is fifteen feet, the breadth twelve feet, and the depth ſixteen inches, but at different works they are of different dimenſions[8]. They are common-

[5] At ſeveral ſalt works, particularly at moſt of thoſe nigh Newcaſtle, they have neither grates, nor aſh pits, but make their fires upon hearths.

[6] See Plate IV. Fig. 1 and 2.

[7] Where they make their fires on hearths, the chimneys are uſually carried up at the end of the pan adjoining to the fore-houſe.

[8] At many works they uſe pans of a much leſs ſize than here deſcribed. But thoſe uſed at Shields and other places nigh Newcaſtle are much larger, being commonly twenty one feet long, twelve feet and a half broad, and fourteen inches deep, being the largeſt ſalt pans uſed any where in Great Britain.

ly made of plates of iron[9], joined together with nails, and the joints are filled with a ſtrong cement. Within the pan five or ſix ſtrong beams of iron are fixed to its oppoſite ſides, at equal diſtances, parallel to each other and to the bottom of the pan, from which they are diſtant about eight inches. From theſe beams hang down ſtrong iron hooks, which are linked to other hooks or claſps of iron firmly nailed to the bottom of the pan; and thus the bottom of the pan is ſupported and prevented from bending down or changing its figure[10].

THE pan, thus formed, is placed over the furnace, being ſupported at the four cor-

[9] The Plates moſt commonly uſed are of malleable iron, about four feet and a half long, a foot broad, and the third of an inch in thickneſs. The Scotch prefer ſmaller plates, fourteen or fifteen inches ſquare. Several make the ſides of the pan, where they are not expoſed to the fire, of lead; thoſe parts, when made of iron, being found to conſume faſt in ruſt from the ſteam of the pan. Some have uſed plates of caſt iron, five or ſix feet ſquare, and an inch in thickneſs; but they are very ſubject to break, when unequally heated, and ſhaken (as they frequently are) by the violent boiling of the liquor. The cement moſt commonly uſed to fill the joints, is plaiſter made of lime.

[10] See Plate III. Fig. 2. and Plate V. Fig. 2. from Agricola; in which the bottom of the pan is ſupported by wood beams fixed at a conſiderable height above the ſalt pan; as is ſtill practiſed at ſeveral ſalt works.

ners by brick work; but along the middle, and at the ſides and ends, by round pillars of caſt iron called taplins, which are placed at three feet diſtance from each other, being about eight inches high, and at the top, where ſmalleſt, four inches in diameter. By means of theſe pillars the heat of the fire penetrates equally to all parts of the bottom of the pan, its four corners only excepted. Care is alſo taken to prevent the ſmoke of the furnace from paſſing into the boiling-houſe, by bricks and ſtrong cement, which are cloſely applied to every ſide of the ſalt pan[11].

Between the ſides of the pan and walls of the boiling-houſe there runs a walk[12] five

[11] In ſome places, as at Blyth in Northumberland, beſides the common ſalt pans here deſcribed, they have a preparing pan placed between two ſalt pans, in the middle part of the building, which in other works is the fore-houſe. The ſea water being received into this preparing pan, is there heated and in part evaporated by the flame and heat conveyed under it through flues from the two furnaces of the ſalt pans. And the hot water, as occaſion requires, is conveyed through troughs from the preparing pan into the ſalt pans. Various other contrivances have been invented to leſſen the expence of fuel; and ſeveral patents have been obtained for that purpoſe; but the ſalt boilers have found their old methods the moſt convenient.

[12] See Plate III. Fig. 2.

or ſix feet broad, where the workmen ſtand when they draw the ſalt, or have any other buſineſs in the boiling-houſe. The ſame walk is continued at the end of the pan next to the chimney; but the pan is placed cloſe to the wall at the end adjoining to the fore-houſe.

The roof of the boiling-houſe is covered with boards faſtned on with nails of wood, iron nails quickly mouldering into ruſt. In the roof are ſeveral openings, to convey off the watery vapours; and on each ſide of it, a window or two, which the workmen open when they look into the pan whilſt it is boiling.

Not far diſtant from the ſaltern, on the ſea-ſhore, between full ſea and low water marks, they alſo make a little pond in the rocks, or with ſtones on the ſand, which they call their ſump. From this pond they lay a pipe, through which, when the tide is in, the ſea water runs into a well adjoining to the ſaltern; and from this well they pump it into troughs, by which it is conveyed into their ſhip or ciſtern, where it is ſtored up until they have occaſion to uſe it.

The ciſtern is built cloſe to the ſaltern,

and [13] may be placed moſt conveniently between the two boiling-houſes, on the back ſide of the foreſide of the fore-houſe; it is made either of wood, or brick and clay; it ſometimes wants a cover, but ought to be covered with a ſhed, that the ſalt water contained therein may not be weakened by rains, nor mixed with ſoot and other impurities. It ſhould be placed ſo high that the water may conveniently run out of it, through a trough, into the ſalt pans.

BESIDES the buildings already mentioned, ſeveral others are required; as ſtore houſes for the ſalt, ciſterns for the bittern, an office for his majeſty's ſalt officers, and a dwelling houſe for the ſalt boilers.

ALL things being thus prepared; and the ſea water having ſtood in the ciſtern, till the mud and ſand are ſettled to the bottom, it is drawn off into the ſalt pan. And at the four corners of the ſalt pan, where the flame does not touch its bottom, are placed four ſmall lead pans called ſcratch pans, which, for a ſalt pan of the ſize abovementioned, are uſually about a foot and an half long, a

[13] Where there is only one ſalt pan the ciſtern is uſually placed at the end of the boiling-houſe; as in Plate II. Fig. 2.

foot broad and three inches deep, and have a bow or circular handle of iron, by which they may be drawn out with a hook, when the liquor in the pan is boiling.

THE ſalt pan being filled with ſea water, a ſtrong fire of pit coal is lighted in the furnace; and then, for a pan which contains about fourteen hundred gallons, the ſalt boiler takes the whites of three eggs [14], and incorporates them well with two or three gallons of ſea water, which he pours into the ſalt pan while the water contained therein is only lukewarm; and immediately ſtirs it about with a rake, that the whites of eggs may every where be equally mixed with the ſalt water.

As the water grows hot, the whites of eggs ſeparate from it a black frothy ſcum, which ariſes to the ſurface of the water, and covers it all over. As ſoon as the pan begins to boil, this ſcum is all riſen, and it is then time to ſkim it off.

THE moſt convenient inſtruments for this purpoſe are ſkimmers of thin aſh boards ſix or eight inches broad, and ſo long that they

[14] Inſtead of whites of eggs, at many ſalterns, as at moſt of thoſe nigh Newcaſtle, they uſe blood from the butchers, either of ſheep or black cattle, to clarify the ſea water. And at many of the Scotch ſalterns they do not give themſelves the trouble of clarifying it.

may

may reach above half way over the ſalt pan [15]. Theſe ſkimmers have handles fitted to them; and the ſalt boiler and his aſſiſtant, each holding one of them on the oppoſite ſides of the pan, apply them ſo to each other that they overlap in the the middle, and beginning at one end of the pan, carry them gently forward together, along the ſurface of the boiling liquor to the other end; and thus without breaking the ſcum, collect it all to one end of the pan, from whence they eaſily take it out.

AFTER the water is ſkimmed, it appears perfectly clear and tranſparent, and they continue boiling it briſkly, till ſo much of the freſh, or aqueous part is evaporated, that what remains in the pan is a ſtrong brine almoſt fully ſaturated with ſalt, ſo that ſmall ſaline cryſtals begin to form on its ſurface; which operation, in a pan filled fifteen inches deep with water, is uſually performed in five hours.

THE pan is then filled up a ſecond time with clear ſea water drawn from the ciſtern, and about the time when it is half filled, the

[15] See Plate VI. Fig. 3.

ſcratch

ſcratch pans are taken out, and being emptied of the ſcratch found in them, are again placed in the corners of the ſalt pan. The ſcratch taken out of theſe pans is a fine white calcarious earth found in the form of powder, which ſeparates from the ſea water during its coction before the ſalt begins to form into grains. This ſubtile powder, is violently agitated by the boiling liquor, until it is driven to the corners of the pan, where the motion of the liquor being more gentle, it ſubſides into the ſcratch pans placed there to receive it, and in them it remains undiſturbed, and thus the greateſt part of it is ſeparated from the brine.

AFTER the pan hath again been filled up with ſea water, three whites of eggs are mixed with the liquor, by which it is clarified a ſecond time, in the manner before deſcribed; and it is afterwards boiled down to a ſtrong brine as at firſt; which ſecond boiling may take up about four hours.

THE pan is then filled up a third time with clear ſea water; and after that a fourth time; the liquor being each time clarified and boiled down to a ſtrong brine as before related; and the ſcratch pans being taken

out

out and emptied every time that the pan is filled up.

Then, at the fourth boiling, as ſoon as the cryſtals begin to form on the ſurface of the brine, they ſlacken the fire and only ſuffer the brine to ſimmer or boil very gently. In this heat they conſtantly endeavour to keep it all the time that the ſalt corns or granulates, which may be nine or ten hours. The ſalt is ſaid to granulate, when its minute cryſtals cohere together into little maſſes or grains, which ſink down in the brine and lie at the bottom of the ſalt pan.

When moſt of the liquor is evaporated, and the ſalt thus lies in the pan almoſt dry on its ſurface, it is then time to draw it out. This part of the proceſs is performed by raking the ſalt to one ſide of the pan into a long heap, where it drains a while from the brine, and is then filled out into barrows or other proper veſſels, and carried into the ſtore houſe, and delivered into the cuſtody of his majeſty's officers, And in this manner the whole proceſs is performed in twenty four hours; the ſalt being uſually drawn every morning[16].

[16] From a pan fourteen feet and a half long, eleven feet and an half broad, and ſixteen inches deep contain-

In

IN the ſtore-houſe the ſalt is put hot into drabs[17], which are partitions like ſtalls for horſes, lined on three ſides and at the bottom with boards, and having a ſliding board on the fore ſide to put in or draw out as occaſion requires. The bottoms are made ſhelving, being higheſt at the back ſide, and gradually inclining forwards; by which means the ſaline liquor, which remains mixed with the ſalt, eaſily drains from it; and the ſalt in three or four days becomes ſufficiently dry,

ing about one thouſand three hundred and five gallons, they draw from fifteen to twenty buſhels of ſalt every day, each buſhel weighing fifty ſix pounds.

At the ſalt works at Shields and other places in Northumberland and Durham they only draw their pans five times in a fortnight, filling them up ſeven or eight times in each proceſs, and from each pan commonly obtain fifty ſix buſhels of ſalt at a draught. They reckon that, in making a ton or forty buſhels of ſalt, they conſume three chaldrons of ſmall pit coal, which coſt them ſixteen ſhillings and ſix pence; and pay to the ſalt boilers for their labour four ſhillings

[17] In ſome places, inſtead of theſe drabs, they uſe cribs, which are veſſels like hay-racks, broad at the top, and tapering to a ſharp bottom, with wooden ribs on each ſide placed ſo cloſe that the ſalt cannot eaſily fall through them. At other works, as at Lemington, they uſe wooden troughs with holes at the bottom, through which runs the ſuperfluous liquor into other troughs placed below to receive it. In other places they draw the ſalt into barrows, or wicker baſkets, out of which the bitter liquor eaſily drains, as will be explained hereafter.

and

and is then taken out of the drabs, and laid up in large heaps, where it is ready for ſale.

The ſaline liquor which drains from the ſalt is not a pure brine of common ſalt, but hath a ſharp and bitter taſte, and is therefore called bittern [18]; this liquor at ſome works they ſave for particular uſes, at others throw away. A conſiderable quantity of this bittern is left at the bottom of the pan after the proceſs is finiſhed; which, as it contains much ſalt, they ſuffer to remain in the pan, when it is filled up with ſea water. But at each proceſs this liquor becomes more ſharp and bitter, and alſo increaſes in quantity; ſo that, after the third or fourth proceſs is finiſhed, they are obliged to take is out of the pan: otherwiſe it mixes in ſuch quantities with the ſalt as to give it a bitter taſte, and diſpoſes it to grow ſoft and run in the open air, and renders it unfit for domeſtic uſes.

After each proceſs there alſo adheres to the bottom and ſides of the pan a white ſtoney cruſt of the ſame calcarious ſubſtance

[18] The marine bittern is a ponderous liquor, exceeding clear, and almoſt as colourleſs as pure water; whereas the bittern drawn from ſome ſalt ſprings is of a browniſh colour.

with

with that before collected from the boiling liquor. This the operators call ſtone ſcratch, diſtinguiſhing the other found in the lead pans by the name of powder ſcratch. Once in eight or ten days they ſeparate the ſtone ſcratch from their pans with iron picks, and in ſeveral places find it a quarter of an inch in thickneſs[19]. If this ſtony cruſt is ſuffered to adhere to the pan much longer, it grows ſo thick that the pan is burnt by the fire, and quickly wears away.

CHAP. II. SECT. II.

Miſcellanious obſervations and cautions relating to the foregoing proceſs.

1. IN the foregoing proceſs the ſalt begins to grain, or form into cryſtals immediately after the brine is brought to ſuch a ſtrength as to be fully ſatiated with ſalt; for if the evaporation be continued any further, the water remaining is not ſufficient

[19] At Hall in Saxony they cleanſe their ſalt pans from the ſtone ſcratch thrice a week, by removing them from off the furnaces, and ſetting them upon one ſide, then burning ſtraw in them, by which the ſcratch is looſened, and falls off by beating the bottom and ſides of the pan with a mallet.

to

to keep all the ſalt diſſolved, which therefore begins to ſeparate from it, and to concrete into cryſtals.

2. Water is fully ſatiated with common ſalt, when each pound of it averdupois contains about ſix ounces of ſalt. For it hath been found by experiments, that ſo much ſalt and no more can be diſſolved in pure water [1].

3. For the better underſtanding of the foregoing proceſs it ought be conſidered that common ſalt, as well as the lixivial ſalt of vegetables, and ſeveral others of the more ſoluble kinds of ſalts, are diſſolved in nearly equal quantities in cold water, and water of a boiling heat. Whereas tartar, nitre, ſeveral kinds of vitriol, and other ſalts, which are leſs ſoluble, or require a large proportion of cold water to diſſolve

[1] Count Marſilli in his *Hiſtoire phyſ. de la mer*, *Partie* ii. pag. 29. aſſures us that a pound of ſea water can only diſſolve an ounce, two drachms, and ten grains of ſalt; but in this and in ſeveral inſtances his experiments have not been made with ſufficient accuracy. His error in this experiment ſeems to have aroſe from uſing the reſiduum of ſea water evaporated to a dryneſs, which he miſtook for pure marine ſalt; and obſerving ſome of it to ſubſide and remain undiſſolved, he concluded that the ſea water was fully ſaturated. More exactneſs

them,

them, may be diſſolved in much greater quantities by hot than by cold water [3].

4. THE marine ſalt is therefore only ſeparated (at leaſt in any conſiderable quantities) from the water in which it is diſſolved, during the time that the water exhales from it in vapours. Moſt of the ſalt being retained in cold water, which was diſſolved in it

might be expected from the illuſtrious Mr. Boyle, although he only allows that one part of ſalt may be diſſolved in five parts of pure water. Boerhaave comes nearer to the truth, when he affirms that pure water is fully ſatiated, when the proportion of ſalt is to that of the water as one to three and a quarter. But Dr. Fred. Hoffman aſſerts, upon the authority of exacter experiments, that a pound averdupois of pure water will diſſolve ſix ounces of ſalt; which is in the proportion of one part of ſalt to two and two thirds of water. See Hoffman *De ſalinis Hallenſ.* C. ii. & *Obſ. phyſ. chem.* Lib ii. Obſ. 17.

[3] Dr. Petit, in his moſt ingenious diſcourſe on the precipitation of common ſalt in refining of ſalt-petre, obſerves, that twenty four drachms of the water of the Seine made ſcalding hot *(très chaude)* diſſolved about eight drachms and an half, or at moſt nine drachms of marine ſalt; and that none of this ſalt was precipitated from the water when cold, no not in the coldeſt winter during the time of the hardeſt froſt; and that the ſame quantity of boiling water did not diſſolve more than nine drachms and an half of ſea ſalt.

But on the contrary, water of different degrees of heat according to the temperature of the air, at different ſeaſons of the year, retained very different quantities of ſalt-petre diſſolved therein. For he obſerved, that, during

 whilſt

whilst hot[4]. So that in the foregoing process it is necessary to continue the evaporation, until the water which keeps the salt dissolved is in a great manner exhaled.

5. BUT in the crystalization of vitriols, nitre, and other less soluble salts, they proceed in another way, and boil the solutions of these salts to a pellicle, or until the hot water is saturated with them. These solutions are then drawn out into proper vessels, and when cool are greatly overcharged with salt, most of which therefore shoots into crystals.

the winter season, in a hard frost, twenty four drachms of the water of the Seine only retained dissolved three drachms of nitre; but in summer the same quantity of water of the same temperature with the external air dissolved ten drachms of nitre; and above seventy drachms of nitre might be dissolved in the same quantity of water made boiling hot.

In all these experiments the quantity of salts dissolved was somewhat different according as the water of the Seine contained more or less of a certain subtile earth, which he calls *Terre fine bolaire*. See the said discourse in the *Memoires de l'Acad Royal des Scien. pour l'Ann.* 1729.

[4] If nine drachms of salt may be dissolved in a certain quantity of cold water, and only nine drachms and an half in the same quantity of boiling water, then a fully saturated brine of the heat of boiling water will, when cold, only let fall the nineteenth part of the salt it contains, if no water exhales from it while it is cooling.

6. IN

6. IN the proceſs of boiling ſea-ſalt great errors are often committed by continuing the evaporation too long, and ſo reducing a conſiderable quantity of the ſalts of the bittern into a ſolid form, along with the marine ſalt.

7. THE cryſtals of ſalt made by the foregoing proceſs are moſt of them broken during the coction, and concreted together into irregular cluſters or grains, from which it is difficult to determine the natural figure of the cryſtals of common ſalt.

8. BUT when, by a very gentle exhalation of water from common ſalt, it is ſuffered to ſhoot into its true form, its cryſtals are found of a cubical figure, of various ſizes; and many of theſe ſmaller cryſtals are united together into hollow pyramids with a ſquare baſe. Theſe pyramids are truncated, being not finiſhed at the top, but having there fixed a cube of ſalt of a more than ordinary bigneſs [5].

[5] The ſalt-petre boilers, who in France preſerve for domeſtic uſes the common ſalt, which they extract in refining of nitre, obſerve, that during the time that the common ſalt precipitates from their lixivium, it ought to be boiled as gently as poſſible in order to have large and beautiful grains of common ſalt. For by this gentle coction, ſay they, the grain forms better, and is

9. It ought alſo to be remarked, that, in the foregoing proceſs, moſt of the ſaline cryſtals are formed nigh the ſurface of the brine, from whence the water is evaporated.

10. A slow and gentle evaporation of the water gives the ſalt liberty to form into large grains.

11. But violent and haſty boiling breaks the tender cryſtals of ſalt and makes the grain ſmall.

12. The ſalt is alſo made of a ſmall grain by ſtirring the brine about during the granulation[6].

13. If the evaporation be ſlowly performed, the ſaline cryſtals concrete into larger cluſters, the longer they remain in the pan.

14. Those therefore, who would have ſalt of a large grain, muſt evaporate the brine very gently, while the ſalt is forming; and muſt ſuffer it to lie a long while in the pan, and muſt not draw it out until it all be formed.

better nouriſhed. For then the grains are not bruiſed ſo violently againſt each other, and againſt the ſides of the cauldron, as when the lixivium is made to boil more briſkly. See the above mentioned diſcourſe of Dr. Petit.

6 See *Ph. Tranſ. Abr.* by Lowthorp, vol. II. p. 358.

15. But

15. BUT thoſe who deſire to have their ſalt of a ſmall grain, boil it pretty haſtily, and draw it out of the brine as ſoon as a conſiderable quantity of it is fallen to the bottom of the pan, often drawing the pan five or ſix times during the time that the ſalt is forming; as will be explained hereafter in treating of the method of preparing baſket ſalt.

16. THE ſalt made by a gentle evaporation of the water is not only of a larger grain, but alſo firmer and clearer, and of a more ſharp and pungent taſte than that which is made with haſty fires.

17. MOREOVER, the ſalt boilers unanimouſly agree, that much of their ſalt is waſted, when violent fires are uſed towards the end of the proceſs, whilſt the ſalt is forming, which they call the time of ſalting; ſo that when they boil violently at that time, they do not obtain ſo much ſalt, as when they uſe more ſlow and gentle fires[7].

18. THEY alſo obſerve, that, when violent fires are uſed during the time of ſalting, the quantity of bittern is conſiderably greater than when gentle fires are applied.

[7] This is confirmed by Dr. Plot, Dr. Hoffman and many others.

19. FURTHERMORE, when they uſe too haſty fires, large quantities of ſalt often adhere to the bottom of the pan; and the operators then ſay that the ſalt is burnt.

20. THE ſalt which thus adheres to the pan, and all ſalt grained with violent fires, is found unfit for preſerving proviſions. Such ſalt will not endure to be long expoſed to the open air, but greedily imbibes the aqueous moiſture, and with it runs into brine; for which reaſon, the operators ſay, that it is not well cleared from the freſh [8].

THE inconvenience of quick fires is fully proved by the practice of the Cheſhire ſalt-boilers; who, about a hundred years ago, made uſe of pans which only held about forty eight gallons of brine, and afterwards pans, which held twice that quantity, being ſomewhat more than a yard ſquare and ſix inches deep [9], and ſo hurried on their work that in the ſpace of two hours they uſually boiled one of theſe pans of brine into ſalt [10].

[8] The ſalt found adhering to the bottom of the pans at the Droitwich ſalt works, and there called clod ſalt, was probably ſalt thus burnt by haſty fires; and was found unfit for preſevring beef.

[9] See a repreſentation of theſe pans with their furnaces and the hot houſes behind them, Plate VI. Fig. 1.

[10] See Dr. William Jackſon's account of the method

But

But the ſalt made in this haſty manner was extreamly weak, and of a ſmall looſe grain, and quickly grew moiſt, though dried in hot houſes, and was therefore only made for preſent ſale[11]. I am well informed, that afterwards they made their ſalt pans gradually larger, until they held about eight hundred gallons; which is the common ſize of the pans now uſed in Cheſhire: And in theſe pans, within the memory of ſeveral now living, they finiſhed their proceſs in twelve hours; and every week reduced twelve pans full of brine into ſalt. They found that the ſalt thus made was greatly preferable to that which they had made before with more haſty fires, but was ſtill too weak for curing proviſions for ſea ſervice. Of late years therefore they have proceded in a more leiſurely way, and only work out ſix pans of brine in the week, emptying their pan only once in twenty four hours. And ſince they fell into this method, their ſalt is much ſtronger, and more durable in the air than heretofore; being eſteem-

of making ſalt at Nantwich in Cheſhire, *Ph. Tr. abb.* by Lowthorp, vol. ii. p. 354, 355.

[11] See Dr. Thomas Raſtel's character of this ſalt, *Ph. Tr. abb.* vol. ii. p. 358, 359.

ed

ed equal in goodneſs to moſt kinds of white ſalt now made; and the demand for it is very greatly increaſed. In making a kind of ſalt called ſhivery ſalt, they uſe yet more gentle fires, and the proceſs continues a longer time than ordinary, as will be hereafter more fully explained. And the ſalt, thus made, is of a larger and firmer grain, and is alſo ſtronger than any other kind of ſalt prepared by them.

CHAP. II. SECT. III.

Memoirs for an Analyſis of ſea water.

FROM the foregoing proceſs it appears that ſea water, beſides common ſalt, contains ſeveral other ingredients; ſome of which in this proceſs, are ſeparated before the common ſalt falls; and others remain in the bittern, after all the ſalt is extracted.

I. OF the firſt kind are the ſand, mud, and other impurities, which by the violent motion of the waves are ſtirred up and mixed with ſea water, and again ſubſide in it, while it reſts in the ciſtern; or elſe are entangled in the whites of eggs and other mixtures, with which it is clarified.

II. BE-

II. BESIDES those groſs ſubſtances, ſea water contains a glutinous matter of a much finer texture, which is intimately diſſolved therein. This glutinous matter, in the foregoing proceſs, is probably ſeparated from ſea water by clarification. If we may give credit to Count Marſilli, it is of ſo light and ſubtile a nature, as to ariſe with ſea water when deſtilled in a ſand heat[1]; and if ſo, may be mixed in rain water, and may greatly promote the growth and nouriſhment of plants[2]; to which uſe (as Dr. Woodward and others have obſerved) a green ſlimy ſubſtance that ſettles in rain water is in a peculiar manner adapted. This viſcous matter of ſea water ſeems earthy, ſaline, and oleagenous. It is this in ſtormy weather, when the waves rage and roar that forms a thick froth on the ſurface of the ſea. To this viſcous part is chiefly owing the putrefaction of ſea water when ſuffered to ſtagnate[3]; by which pu-

[1] See his *Hiſtoire phyſique de la mer*, *Partie* ii. p. 26.

[2] The antients therefore might have ſome reaſon for feigning that Venus ſprang from the foam of the ſea. Of whom Lucretius ſings,

> Quæ, quoniam rerum naturam ſola gubernas,
> Nec ſine te quicquam dias in luminis oras
> Exoritur, neque fit lætum, neque amabile quicquam.

[3] Of the putrefaction of ſea water when kept

trefaction

trefaction this ſlimy matter is ſo attenuated, that its texture is deſtroyed and part of it flies off in fetid exhalations, which are probably inflammable and permanently elaſtic; for it hath been obſerved, that the water of the Thames and other rivers generate an inflammable air during their putrefaction in long voyages. The more groſs and earthy

in veſſels, ſee the reverend Dr. Hales's *Phil. experiments.*

And that the whole maſs of ſea water is ſubject to corrupt, when ſuffered to ſtagnate, Mr. Boyle hath given us the following inſtances, " A navigator of my acquaintance, having often ſailed in the Indian and African ſeas, told me that being once, though it was in the month of March becalmed in a place for twelve or fourteen days, the ſea, for want of motion, and by reaſon of the heat began to ſtink; ſo that he thinks if the calm had continued much longer, the ſtench would have poiſoned him. They were freed from it, as ſoon as the wind began to agitate the water, which alſo drove away ſhoals of the ſea tortoiſes and a ſort of fiſh that before lay baſking on the top of the water."

And Sir John Hawkins takes notice; that " were it " not for the moving of the ſea by the force of winds, " tides, and currents, it would corrupt all the world. The " experience I ſaw, ſays he, in the year 1590, lying with a " fleet about the iſlands of Azores, almoſt ſix months, the " greateſt part of the time we were becalmed; with " which all the ſea became ſo repleniſhed with ſeveral " ſorts of gellies, and forms of ſerpents, adders, and ſnakes, " as ſeemed wonderful; ſome green, ſome black, ſome " yellow, ſome white, ſome of divers colours, and " many of them had life; and ſome there were a yard " and an half, and two yards long, which had not I

parts

parts of this viſcuous matter, after its texture hath been thus broken by the putrid fermentation, ſubſide in the ſea water (and as the reverend Dr. Hales hath obſerved) fall to the bottom of the veſſel in a dirty ſediment.

III. BESIDES this viſcous matter, ſea water probably holds an earthy ſubſtance ſo very light and ſubtile that in the foregoing proceſs it is elevated along with the watery vapours; as there ſeems reaſon to conjecture from a white ſubtile earth, which I have obſerved adhering to the walls of ſeveral boiling-houſes. And although it may ſeem abſurd to talk of a volatile earth; yet certain it is, that ſeveral ſubſtances known to chemiſts by the name of ſaline earths, are raiſed from certain bodies by their efferveſcent motions, or by the force of fire. Such are thoſe volatile fumes that ariſe from quick lime when water is poured upon it; and ſuch is

" ſeen, I could hardly have belived. And hereof are " witneſſes all the company of the ſhips, which were " then preſent; ſo that hardly a man could draw a " bucket of water clear of ſome corruption. In which " voyage towards the end thereof many of every ſhip fell " ſick of this diſeaſe, and began to die apace; but that " the ſpeedy paſſage into our country was a remedy for " the crazed, and a preſervative for thoſe that were not " touched." See Boyle on the *Saltneſs of the ſea.*

the

the ſubtile alcaline earth of lime water, which ariſes with it in deſtillation[4].

But we are more certain of the preſence of another kind of earth in ſea water, which in the foregoing proceſs is obtained from it in very conſiderable quantities. This earth, to which the ſalt boilers have given the name of ſcratch[5], ſeparates from the brine before the ſalt begins to form in it; and is either taken out in the ſcratch pans in the form of a white powder, or elſe adheres to the bottom, and ſides of the ſalt pan in a hard ſtoney incruſtation. This earth may alſo be probably ſeparated from ſea water by congelation. At leaſt, I have found that Briſtol water, frozen into ice and afterwards thawed, depoſits a white calcarious ſediment, very

[4] I was informed by a gentleman of great judgment and veracity, who ſuperintends ſeveral large colaieries, that when he boiled water which ſprang out of a bed of free ſtone in the boiler of a fire engine, the cylinder, into which the watery vapours aroſe, was often ſo filled with a ſtony powder, that the piſton of the engine could not move in it, until the powder was cleanſed out; for which reaſon he was obliged to ſupply the engine with other water.

[5] By Dr. Collins in his diſcourſe on ſalt and Fiſheries, it is called ſtone powder: By Dr. Liſter *de font. Med. Angliæ* Arena alba, and lapis albus: By Dr. Fred. Hoffman, Pulvis candidus. And by the ſame, moſt aptly, Succus maris, Salino-terreus, calciformis.

 much

much reſembling the ſcratch of ſea water. The petrifying water of Knareſborough being in like manner froze, doth alſo part with its ſtony matter. Theſe earthy particles are not ſeparated from ſea water in the ſame ſtate in which they were diſſolved therein; for when by coction a large quantity of the water is evaporated and thereby theſe particles are brought into cloſer contact, they ſtrongly attract each other, and remain no longer ſuſpended in the water; but firmly concrete into large cluſters; which cannot again be diſſolved in water[6], unleſs they be firſt diſunited by art, and reduced into ſuch minute particles as they exiſted in before their union.

THAT theſe particles are extremely ſmall and minute while diſſolved in water, appears from their paſſing with it through the filtre[7]; ſo that, during their diſſolution, they ſeem ſufficiently fine and ſubtile to enter the veſſels of animals and vegetables. And in-

[6] Hence appears the reaſon, why, if the dry remainder extracted from ſea water be again added to the water deſtilled from it, it is not of the ſame ſpecific gravity it was of before deſtillation; each pound of it, according to count Marſilli, wanting a ſcruple of its former weight.

[7] See *Exp.* made by Dr. Plot, *Nat. Hiſt. of Stafford-ſhire*, Chap. ii. § 109, 110.

deed

deed this ſubtile earth appears to be a very neceſſary ingredient in ſea water, ſerving for the nouriſhment of marine plants, and alſo of many fiſh, more particularly of the teſtaceous and cruſtaceous kinds; to whoſe coverings, as well as to corals and ſeveral other ſtoney plants, it hath a great affinity.

By a ſubtile earth of this kind may be produced ſeveral ſtony incruſtations, and petrefactions of moſs, wood, and other vegetable ſubſtances; alſo ſtalactites, and other ſtony concretions[8].

This earth is capable of being diſſolved by water in very conſiderable quantities. The water of the ſalt ſprings of Weſton in Staffordſhire contains about a thirty ſixth part of its whole weight of this earth; which is nearly in the ſame proportion, in which common ſalt is uſually found diſſolved in ſea water[9].

The great ſolubility of this earth in water, ſhews that it nearly approaches to the nature of ſalts. It is even found to enter the

[8] See an inſtance of this kind in the following chapter from Dr. Scheuchezr's *Account of the Saltworks at Bevieux in Switzerland.*

[9] See Dr. Plot's *Nat. Hiſt. of Staffordſhire*, C. ii. § 104.

compo-

composition of perfect salts. For being long exposed to the open air, it imbibes the aereal vitriolic acid, and with it is converted into a neutral salt, which Dr. Lister ranks amongst the species of his calcarious nitre[10]. This salt, in taste, very nearly resembles the bitter purging salt of Epsom waters; as I experienced in some of it which I found germinated on stone scratch, that had been kept by me four or five years.

FROM the foregoing observations, this earth appears to have an alcaline quality; which is further confirmed by other experiments. For when reduced to powder, and mixed with syrup of violets diluted with water, it instantly turns the mixture from a blue to a green colour. I have known the glass makers substitute it for kelp in their composition for making glass. And it is well known that kelp, or the ashes of the herb kali, owes its quality of vitrifying with sand, chiefly to the alcaline salt which it contains. This earth, being mixed with clay, makes a strong cement, which the salt boilers use for repairing their furnaces.

[10] In his treatise *De fontib. medicat. Angliæ*, L. i. p 36.

IT

It is well known that the ſhells of the ſea fiſh (which ſeem to be nouriſhed chiefly by this ſubtile earth) partake of an alcaline nature, and may by calcination be reduced into quicklime; to which, we may conjecture from the preceeding experiments, that this earth bears ſome affinity. And having purpoſely made the trial, I found that ſtone-ſcratch after calcination by a violent heat in an air furnace, fell into powder in the open air, and had other properties of quick lime.

The marine ſcratch therefore ſeems to deſerve the title of a ſaline calcarious earth. But I am far from thinking that all earths which come under that general denomination, are exactly of the ſame nature, and agree in all their properties. On the conrary it is more reaſonable to believe that there are ſeveral kinds of calcarious earth, which are more or leſs ſubtile, more or leſs corroſive, and have other ſpecific differences; one kind bearing a reſemblance to chalk, another to limeſtone, a third to quick lime, and a fourth to alabaſter; one kind, with the vitriolic acid compoſing alum, another with the ſame acid Epſom-ſalt, and others with the ſame acid

other

other kinds of calcarious ſalts. So that theſe earths ought not to be all confounded together, but each kind diſtinguiſhed by its private properties.

THE magneſia alba, ſo juſtly celebrated in Germany for its mild purgative anti-acid virtues, is a kind of calcarious earth, very neary related to the ſcratch of ſea water; being with acids converted into a bitter purging ſalt, which is not the caſe with quick-lime, crabs eyes, and ſeveral other alcaline earths. Whether the marine ſcratch will have the ſame effects with the magneſia upon the human body, muſt be determined by future trials. It is certain that ſeveral mineral waters owe their purging qualities not to any perfect ſalt with which they are impregnated; but to a ſubtile calcarious earth, as Dr. Fred. Hoffman hath fully proved in the waters of the Caroline baths in Germany.

IN the examination of mineral waters; their earthy ingredients, which are too often conſidered as inert, and without efficacy, do therefore require a nicer attention. We find that calcined ſpunge, which is a marine production and holds a calcarious earth, is a uſeful remedy in ſcrophulous diſorders; and the ſalutary effects, which ſeveral mineral waters,

and which ſea water hath alſo been obſerved to produce in thoſe diſtempers, may be attributed, in part at leaſt, to the calcarious earth which they contain. There are many purging waters, as thoſe of Epſom and Scarborough, which agree with ſea water in that they hold a calcarious earth, together with a muriatic and a calcarious ſalt. But how far the earths of theſe waters agree with the marine ſcratch, and in what they differ from it, and from each other, can only be determined by proper experiments.

IV. The ingredient of ſea water, which, in the foregoing proceſs, falls next under our conſideration, is common ſalt. And the quantity of this ſalt contained in ſea water, is found very different in different parts of the ocean, and even in the ſame parts at different times.

The Baltic ſea, receiving more freſh water than exhales from it, is but weakly impregnated with ſalt. The water of the Britiſh and German ſeas, is conſiderably ſalter than that of the Baltic; and the water of the Mediterranean (from which more freſh water is thought to exhale than falls into it) is eſteemed ſalter than that of the Britiſh or German ſeas; and the water of other ſeas may probably contain a larger proportion of

ſalt than that of the Mediterranean, as hath been conjectured of the water on the coaſt of Moſambique[11].

A phyſician, to whom Mr. Boyle recommended the trial, affirmed, that in ſailing from England to the Weſt Indies, he found the water of the ocean to increaſe in gravity, the nearer he came to the line, till he arrived at a certain degree of latitude (as he thought) about the thirtieth; after which, it ſeemed to retain the ſame ſpecific gravity 'till he came to Barbadoes or Jamaica[12]. But the authority of this gentleman does not ſeem of ſuch weight as that of father Feuillée, who, in paſſing through the ſtreights of Gibraltar towards America, obſerved the water to diminiſh in weight in proportion as he approached the line[13].

THIS difference in the ſaltneſs of the ſea in different places, ſeems to proceed from various cauſes. As, from the quantity of vapours exhaling from it, which is very different in different places. Alſo from the quantity of freſh water received into certain

[11] See Boyle *on the Saltneſs of the ſea, abb.* by Dr. Shaw, vol. iii. p. 224.

[12] See the ſame work, p. 223.

[13] See *Memoires of the Royal Acad. for the year* 1711.

parts of it, in rains, or from the mouths of rivers[14]. Or from beds of foſſil ſalt, which may be ſeated in ſeveral places at the bottom of the ocean[15]. Or from the ſalt waters of ſprings and rivers which are diſcharged into it, in certain places[16].

[14] Count Marſilli found the water of the Archipelago taken up nigh Smyrna conſiderably heavier than that of the Euxine; and that of the channel of Conſtantinople, or the Thracian Boſphorus, in ſome places heavier, in others lighter than that of the Euxine according as it was taken up nearer to, or farther from the mouths of rivers. See his *Obſervations made on the Boſphorus of France.*

Such vaſt quantities of water are diſcharged from the Riv della Plata in Brazil, that freſh water may be taken up in the ocean fifteen miles from the mouth of that river. The ſame is reported of the river Quire in Africa.

On the coaſt of Malabar, during the rainy ſeaſon, ſo much water falls in rains, and is diſcharged from rivers, that the ſea water in ſeveral parts nigh land becomes almoſt ſweet and potable. Du Hamel Phil. Burgund. Cap. *De maris ſalſedine.*

[15] As nigh the iſle of Ormus. And in deep parts of the ocean, where the water is not diſturbed, the ſalt may diſſolve very ſlowly, as all the water adjoining to the ſalt rocks will be fully ſatiated with it.

[16] Moſt of the rivers in the kingdoms of Algiers and Tunis are impregnated with ſalt; and doubtleſs contribute to the extraordinary ſaltneſs of the Mediterranean waters. Herrera informs us, that the Rio de la ſal in Chili is ſo extremely ſalt, that the parts of horſes wet with it, as ſoon as they are dry, appear incruſted over

THE reverend Dr. Hales, by a gentle evaporation of sea water taken up near the Buoy at the Nore at the mouth of the Thames obtained from it $\frac{1}{29}$ 2 of its whole weight of salt. And from the Mediterranean water taken up thirty leagues north of the isle of Malta $\frac{1}{27}$ 3 of salt[17]. Count Marsilli found that water taken from the surface of the sea in the gulf of Lyons, yielded by a gentle distillation only $\frac{1}{32}$ of its whole weight of salt; whilst that which was taken up at the same time and place from a great depth yielded $\frac{1}{29}$ of salt; and hence concludes that sea water is much salter in profound parts of the ocean, than at the surface[18]. This indeed may be the case in the gulf of Lyons nigh the mouths of the Rhone; and also nigh the mouths of other great rivers, whence the fresh water flowing out, is mixed chiefly with the superficial sea water, whilst that in deep parts remains undisturbed. But this rule does not hold universally true in all places; for Mr. Boyle found the water of the British channel equally heavy at the sur-

with salt; and that the salt lies concreted on the borders of the river.

[17] See his *Ph. Experiments on distilled sea water.*

[18] See his *Histoire Phys. de la Mer.*

face and at the bottom. And at ſome places (as in the Pacific ocean) where large quantities of water ariſe in vapours, and very little falls again in rains, or is received from rivers, the ſuperficial water may probably be much ſalter than that which remains undiſturbed at the bottom.

It ought to be remarked, that in the foregoing experiments of extracting the ſalt from a certain quantity of ſea water, all the dry remainder hath uſually been taken for common ſalt; although it is not a pure marine ſalt, but hath ſeveral other ingredients mixed with it, particularly a conſiderable portion of a calcarious earth, and alſo the ſalts of the bittern. It likewiſe ever contains a conſiderable portion of aqueous moiſture, which is more or leſs according as the heat was continued a longer or a ſhorter time after the impure ſalt or remainder appeared in a dry form. Mr. Boyle having evaporated water taken up in the Britiſh channel to a dryneſs, found the dry remainder, which he calls ſalt, to weigh near $\frac{1}{30}$ of the whole water; but after heating and drying it well in a crucible, it only weighed $\frac{1}{37}$ of the water uſed[19]. The

[19] See his *Treatiſe on the ſaltneſs of the ſea.*

quantity

quantity of dry remainder will alſo be conſiderably leſs when the water is evaporated from it with a violent heat, than when only a gentle heat is applied. So that from theſe experiments, in which a certain quantity of ſea water is evaporated, and the impure ſalt remaining weighed; nothing certain can be determined of the true quantity of common ſalt which ſea water doth contain.

As true an eſtimate may probably be made from the experiments of the ſalt boilers. Thoſe of them who have been moſt accurate in their trials affirm that in Solway Firth on the coaſts of Cumberland, they commonly obtain a pound of pure marine ſalt from forty pounds of ſea water; and after the greateſt draughts, ſeldom more than a pound of ſalt from thirty five pounds of water; but, after heavy rains and great land-floods, the ſea water is there ſo weakened, that it does not afford above a fiftieth part of its weight of pure ſalt. The Newcaſtle ſalt boilers aſſert, that, on the coaſts of Northumberland and Durham, from thirty tuns of ſea water, they uſually extract a tun of ſalt; but in this calculation it is probable that they do not eſtimate the quantity of water by weight, but by meaſure.

From all theſe obſervations, it may be concluded in general that ſea water taken up on the Britiſh coaſts, at ſome diſtance from the mouths of rivers, ſeldom holds more than $\frac{1}{30}$, or leſs than $\frac{1}{50}$ of common ſalt. And that the water of ſome ſeas, as of the Baltic is impregnated with leſs ſalt, and that of the other ſeas with more ſalt, than the water taken up on the coaſts of Great Britain.

Besides common ſalt, ſea water contains ſeveral other ſalts which are found in the bittern that remains in the pan after all the marine ſalt is extracted.

V. For firſt it contains a bitter purging ſalt, known better to many by the name of Epſom ſalt; having firſt been extracted for medical uſes from the waters of Epſom, and afterwards from thoſe of Dulwich, Shooters-hill in Kent, and from other purging waters in ſeveral parts of England. But all this ſalt now vended, is prepared intirely from the marine bittern, at the ſalt works nigh Newcaſtle, and at thoſe at Lemington and other parts of Hampſhire. To this ſalt ſeems chiefly owing the bitter taſte of ſea water, although the opinion hath generally prevailed that this taſte proceeded from

from bitumen[20]. From the experiments made on this ſalt, it ſeems compoſed of a vitriolic acid, united to a large quantity of a

[20] I readily grant that there are ſeveral bituminous bodies, which in various parts are mingled with the marine waters. Thus Mr. Boyle informs us that the Barbadoes tar is carried in conſiderable quantities from rocks into the ſea. And count Marſilli obſerved ſpiral filaments to ariſe in the ſea Marmora nigh Conſtantinople, which concreted into bitumen exactly of the ſame kind with that which he had obſerved to flow from a bituminous fountain in the iſle of Zant. On ſome of the coaſts of Italy they ſkim an oil like petrolium from the ſurface of the ſea. And ambergreece may probably be a bituminous ſubſtance caſt up from the ocean. Many parts of the ſea are alſo frequently covered with a ſubtile pinguous ſubſtance, which ſhines and gives light in the night. Theſe unctuous ſubſtances may impart various properties to ſea water in places where they abound; but none of them are found conſtantly mixed with the marine water; nor does it appear that they are capable of giving it its bitter taſte; ſo that this taſte ſeems to proceed almoſt entirely from the bitter purging ſalt, every where preſent in ſea water. Count Marſilli hath indeed proved that a ſpirit diſtilled from pit coal will give water a bitter taſte, but he hath not proved that ſea water is impregnated with ſuch a ſpirit; on the contrary diſtilled ſea water hath no bitter taſte, as Dr. Hales hath well remarked, and therefore the marine waters are not impregnated with ſuch a volatile ſpirit, but owe their bitterneſs to a fixed principle. And that pit coal can ſcarce impregnate water with ſuch a fixed principle, appears from examining the water which flows from large ſtrata of this mineral; which water is commonly impregnated with iron, but hath never been obſerved to have a bitter taſte.

calcarious

calcarious earth; and may therefore be called a vitriolic calcarious ſalt[21].

VI. Another ſalt is found in bittern, which may be called a muriatic calcarious ſalt; its acid principle being ſpirit of ſalt, which is loaded with a large quantity of an earthy ſubſtance moſt nearly related to quicklime. For this ſalt, being expoſed to the fire, doth not part with its acid ſpirit until its ſaline earth is reduced to a calx more ſharp and corroſive than quicklime itſelf. This ſalt remains in the bittern after the bitter purging ſalt is extracted from it; and, though a neutral ſalt, can ſcarce be brought into cryſtals, but by the force of fire may be reduced to a ſolid form; which yet it retains with difficulty; for of all the coagulable ſalts, it moſt greedily imbibes the aërial humidity, and with it moſt readily runs per deliquium[22], This ſalt, though little known,

[21] Of this and the following ſalt ſee an account publiſhed in the *Tranſ. of the Royal Society* N° 377, 378. by Mr. Brown the Chemiſt.

Alſo Dr. Hoffman's *Obſ. Phyſ. Chem. De Lixivio a ſale relicto.*

[22] The great reluctancy which this ſalt diſcovers to be reduced to a ſolid form, ſeems alſo to ſhew the near affinity between its earth and quicklime. For Sthal informs us, that thoſe who putrify nitre find no better me-

is now applied to ſome profitable uſes [23], and might be applied to other uſes medical as well as œconomical; which are left to the diſcovery of the ingenious.

VII. BESIDES theſe calcarious ſalts, the marine bittern contains a conſiderable portion of a fixed mineral alcali, as may be judged from its turning ſyrup of violets of a green colour. Whether this ſalt exiſts in ſea water before its coction, ſeems difficult to determine, as will more fully appear from ſome experiments hereafter to be related. It is however certain, that ſea water partakes of an alcaline quality; for though the colour of ſyrup of violets is not readily changed by it, yet the blue tincture of flowers of Cyanus (which more quickly turns red with acids and green with alcalies than ſyrup of violets) being mixed with ſea water, the mixture in about twelve hours becomes of a pale green, as I have frequently experienced.

thod of freeing it from marine ſalt than by mixing it with lime water; which uniting to the acid of ſea ſalt, therewith forms a ſaline liquor, which will not ſhoot into cryſtals.

[23] Amongſt thoſe uſes, I do not reckon one to which ſome have applied it; counterfeiting therewith the blood of the Popiſh ſaint Januarius; which, as many believe, liquefies at the approach of the head of that ſaint.

But

But whether this change of colour proceeds from the calcarious earth or from a ſmall portion of an alcaline ſalt contained in ſea water, muſt be determined by future experiments. It however ſeems ſtrange that ſo alcaline a ſubſtance as ſcratch, which, when reduced to powder, ſo readily turns theſe mixtures green, ſhould yet have ſo little effect upon them when more intimately diſſolved in ſea water.

THE ingredients of ſea water already mentioned are the chief which fall under the cogniſance of the marine ſalt-boiler. Although it is alſo impregated with the ſeeds, ſperm, and excrements of innumerable kinds of plants and animals, and the tinctures which thoſe plants and animals impart to it, while they corrupt and diſſolve therein. Theſe, together with diverſe ſaline and ſulphureous bodies not here mentioned, will neceſſarily fall under the conſideration of thoſe, who ſhall hereafter attempt to oblige the world with a natural hiſtory of the marine waters [24]. To whom, as well as to the

[24] It may indeed ſeem ſtrange, that, after the learned have ſpent ſo much time and ſtudy in ſearching into the nature of mineral waters, the water of the ocean, that grand fountain of fountains, which nou-

inqui-

inquiſitive ſalt-boiler, the imperfect memoirs here given may not be wholly unuſeful.

CHAP. III. SECT. I.

The method of boiling brine ſalt.

OF ſalt boiled from the waters of wells and ſprings, which we call brine ſalt, great quantities are daily made and uſed; eſpecially in countries remote from the ſea, as in the inland parts of Germany, in Hungary, and Switzerland, in which and in many other countries, ſprings of ſalt water are very common [1].

riſhes and ſupports ſuch an infinite variety of creatures; which hath ſuch remarkable effects upon the human body, which diffuſes its influence over the whole ſublunary creation, and is ſo wonderfully adapted to the various ends of the all-wiſe creator; ſhould nevertheleſs remain almoſt totally neglected by them.

[1] Amongſt the moſt remarkable ſalt ſprings, may be ranked thoſe of Salins in Franché Compté; art ſeeming to vie with nature, in contributing to render them moſt ſurprizing. Theſe ſprings are ſituated in deep caves, which in the greater work (for there are two in that City) are about four hundred feet in length, and fifty or ſixty in breadth. Into theſe caves (of the greater work) they deſcend by a ſtone ſtair-caſe of forty one ſteps, and then by wood-ſtairs of twenty ſteps. At the bottom of theſe ſtairs, is a cave with an arched roof.

In

In ſeveral parts of England, as in Somerſetſhire, Cumberland, Weſtmoreland, Dur-

This firſt cave or vault is forty feet long, and thirty two and an half broad; and in it are ſix ſprings of ſalt water, and two of freſh water, all which guſh out of the ſame rock, within the ſpace of fourteen feet. From this cave or vault they go into others, ſupported in the middle by a row of thick pillars, on which double arches reſt. They then paſs through two gates into a ſpacious vault thirty five feet high, and ſupported nigh the enterance by four ſtrong pillars placed ſquare ways, and in the middle ſpace within theſe pillars is a large baſon, into which the waters of the ſeveral ſalt ſprings are collected. In the ſame vault beyond theſe pillars are four others, placed in a row ſupporting different arches of ſixty feet in length, and forty eight feet in breadth; beyond which there is an irregular ſpace ſixty three feet long, in which are ſix or ſeven ſprings of ſalt water, and ten or twelve of freſh.

The ſalt waters of theſe ſprings, and of the ſix ſprings before mentioned, are kept ſeparate from the freſh water; and are all conveyed through gutters into the large baſon before mentioned. From this baſon they are drawn out, by an engine called the wheel and buckets, into four large ſtone baſons or reſervoirs, one of which holds fifteen thouſand hogſheads, and the other three together twenty five thouſand hogſheads. From theſe reſervoirs they are drawn off, as occaſion requires, into ſmaller ciſterns placed nigh the boiling houſes (the waters contained in the ſeveral baſons, (as they are drawn from the ſprings at different times, and are of unequal ſtrength) are mixed together in ſuch proportions in the ciſterns, that each pound yields about three ounces of ſalt. The water of the freſh ſprings is alſo collected together in the caves, into a baſon prepared to receive it, and is raiſed by means of a crane to the level of a little

ham,

ham, and Yorkſhire, many ſalt ſprings have been diſcovered; but they are either weak, or ſituated where fuel is ſcarce; and for theſe and other reaſons, are not wrought for ſalt.

BUT in other parts of England there are many rich and valuable ſalt-ſprings, from which great ſtore of ſalt is daily extracted. Of theſe ſome are ſituated in Stafford-ſhire, and ſeveral in Lancaſhire; but the chief are thoſe at Droitwich in Worceſter-ſhire, and Northwich in Cheſhire, about which laſt mentioned place, there are many rich mines of foſſil ſalt; above and beneath the beds of which, the brine is commonly found. And when, as it frequently hap-

brook, into which it runs through a ſubterraneous conduit. For a farther account of theſe ſprings and and ſaltworks, See the *General Syſtem of Geography* lately publiſhed at London vol. i. p. 346.

The ſalt ſprings in England and other countries are, moſt of them, wells or pits of different depths, in ſome of which the brine ſtagnates, and never riſes to the top, but flows out at the top of other wells, when it is not drawn out for uſe. See a Deſcription of the ſalt ſprings at Hall in Saxony in Hoffman's Treatiſe *Des Salinis Hallens:* Alſo of ſeveral in England in the *Ph. Tr. Ab.* vol. ii.

At ſome plcaes, as at Schower in upper Hungary, the water which they draw from their ſalt mines, being a very ſtrong brine, they boil into ſalt.

pens,

pens, the ſalt is in a good meaſure exhauſted, and the brine is ſo weak, that it can no longer be wrought to profit; they then ſink pits in other likely places, and ſeldom fail of meeting with ſtrong brine. There are alſo many brine ſprings in other parts of the laſt mentioned county, as at Middlewich and Nantwich [z], at the laſt of which places the pits are of a very ancient ſtanding, and are ſaid to have been wrought in the time of the Roman government.

THE brine of theſe ſprings is obſerved to differ greatly in ſtrength and purity; ſome kind of brine affording a much larger quantity of ſalt, and fitter for moſt uſes, than that which is extracted from other fountains.

THAT brine may be eſteemed the ſtrongeſt of which a pound averdupoize yields ſix ounces of pure ſalt. The brine of Barton in Lancaſhire, and of ſeveral pits at Northwich is nearly of this ſtrength, being almoſt fully ſaturated with ſalt. That of Droit-

[z] Moſt of which are ſituated nigh the river *Weewer.* "Sink on either ſide the ſaid river for many miles, "and you will ſcarce miſs of brine." *Liſter's Obſ. on the midland ſalt ſprings. Ph. Tr. Abb.* by Lowthorp. vol. p. 361.

wich, Upwich and Middlewich contains about a quarter of ſalt. The brine of other ſprings at Northwich and Nantwich yields about a ſixth, and that of Weſton in Staffordſhire only about a ninth part of ſalt: In England they ſeldom boil a weaker brine alone, than that laſt mentioned; but in ſome parts of Germany, where ſalt is very ſcarce, they extract it from water which is more weakly impregnated with it, than the marine waters.

IT hath been obſerved at ſeveral ſalt ſprings, that the brine is much ſtronger at the bottom of the pits than nigh the ſurface; alſo in dry weather than in wet; and when the pits are conſtantly drawn, than when little brine is drawn out of them. But in ſome ſprings, as in thoſe of Salins in Franche-Comté, the brine is not only found more plentiful, but alſo ſtronger after wet, than after dry weather.

BESIDES common ſalt, the brine of moſt ſprings is impregnated with many other ingredients, with the nature and properties of which the brine ſalt-boiler ought to be acquainted, as by that means he will be enabled to exerciſe his art with greater dexterity and judgment.

And first, the brine of most salt wells, and particularly the English brine, hath something of a sulphureous principle mixed with it, as may be concluded from its fetid sulphureous smell, which quickly goes off with boiling[3]. This sulphureous principle gives to the brine impregnated with it, an intestine putrifying motion; and makes it quickly corrupt the flesh of animals steeped therein.

2. The brine of many of the English salt springs turns atramentous with galls[4], and hath mixed with it an ochery substance,

[3] "The brine of the Droitwich pits (as Dr. Lister "assures us) stinks like rotten eggs, and will, if flesh be "pickled with it, make it stink in twelve hours. And "yet (adds he) the salt that is boiled of these pits is ac-"counted the very best inland salt of all England, and, "I believe, as good as any in the world." *Ph. Transf. abr.* by Lowthorp, vol. ii. p. 362.

It hath since been found that the Droitwich brine, after it is boiled and clarified, is an excellent pickle for curing beef, and other domestic uses.

In the level or gallery, through which the salt water is conveyed to the salterns at Bevieux in the Pais de Vaux, Dr. Scheuchzer observed several veins of virgin sulphur. Several of the miners, in digging the said level, were killed by explosions of the fulminating damp.

[4] This Dr. Lister observes of the brines of Nantwich, Middlewich, Northwich, Weston, and Droitwich.

Dr. Leigh, in his *Nat. Hist. of Lancashire and Cheshire*, affirms, that there are several salt springs in those counties, the brine of which is not altered by galls.

which

which ſeparates from it, and ſubſides, when the brine is ſuffered to ſtand in an open veſſel; or falls to the bottom of the ſalt pan as ſoon as the brine begins to boil.

3. BRINE hath alſo commonly mixed with it a large quantity of a light calcarious earth, or ſcratch, exactly reſembling that of ſea water. It abounds in the Cheſhire brine, and in all their ſalterns they collect it into ſcratch pans; and once a week, or oftener, pick off the ſtoney cruſt which adheres to their ſalt pans. It is alſo found in the brine of the German ſalt ſprings. And it is probably the peculiar excellency of the Droitwich brine to be intirely free from any mixture of this earth [5].

[5] Dr. Scheuchzer gives the following relation of the manner of depurating the brine from part of this earth at the works at Roche, or Bevieux. "Antequam vero in "ipſas cortinas, quæ ferreæ ſunt, admittitur (aqua ſalſa) "depuratur in alveo prælongo ducentorum forte pedum, "decem circiter lato, tecto columnis inſiſtente, "a pluviæ miſcela munito: hic ordine ſuſpen-"duntur faſciculi ſtraminum octo circiter pedum, "quibus aqua ſalſa ex alveo aſperſa affigit particulas "terreas, quæ ſenſim ad digiti fere craſſitiem incruſtant "ſtramineos culmos, atque tunc rejiciuntur, ut novis faſci-"culis ſtramineis ſuſpendendis locum cedant. Adno-"tari meretur, horum Stalactitarum vel Striarum arte-"factarum non externa ſolum cylindricâ figurâ ita ſæpe "concreta, ut maſſa Stelechiten vel Stalactiten ramoſum "referat, ſed præprimis ſtructura interna veluti radiata "radiis undique a peripheria ad centrum convergentibus

4. At the bottom of ſeveral brine pits there is found a light black mud; which, when ſtirred up, infects the whole ſpring, like the ſcuttle fiſh, black. Some of the pits in Cheſhire, which abound with this mud, are in boggy grounds, where the ſoil is a peat earth. The briners there frequently empty theſe pits, in order to cleanſe them from this mud. At Hall in Saxony, they fix bundles of rods in the middle of their pits; through which the brine paſſing, this mud is intercepted, as by a ſtrainer.

5. The brine of moſt ſprings is alſo imbued with various kinds of ſalts. In boiling the waters of the German ſalt ſprings there remains a ponderous liquor, which they call *Mutter ſoole*, or mother brine, reſembling the marine bittern, but ſeeming to partake more of the muriatic calcarious, than bitter ſalt of ſea water, as may be concluded from the experiments made thereon by Dr. Fred. Hoffman[6]. Moſt of the mineral waters of England, which are impregnated with bitter ſalt,

" inſignita, cui geneſi anſam dedit æqualis undique " partium terrearum ad ſtramen adhæſio; materia ha- " rum Striarum eſt coloris terrei fere vel flaveſcentis, " ſubſtantiæ ſpecularis, ut ipſorum Stalactitarum." *Iter Alpinum ſeptimum.*

6 *Obſ. Phyſ. Chem.* Lib. ii. Obſ. xviii.

do

do with it hold plenty of common ſalt. And we are aſſured by Dr. Leigh, that thoſe two ſalts are alſo found together diſſolved in the brine of Cheſhire [7].

6. HOFFMAN informs us, that ſeveral of the ſalt ſprings in Germany are impregnated with a mineral alcali; and many of the Engliſh brine ſprings ſeem alſo to partake of the ſame, as will be more fully diſcuſſed hereafter.

THE antient methods of boiling brine into ſalt in Cheſhire and Worceſterſhire are accurately deſcribed in the acts of the Royal Society; and the method formerly uſed in Staffordſhire is related in Dr. Robert Plot's *Natural hiſtory* of that county, to which accounts the reader is referred. The method now practiſed in thoſe counties, agrees pretty well with that uſed in Germany; and as it differs in ſeveral particulars from the method of boiling ſea ſalt, before related, it is neceſſary here to give a ſhort account of it.

THE brine being received from the well

[7] "Beſides the marine ſalt, theſe ſprings do likewiſe "contain the nitrum calcarium." Leigh, *Nat. Hiſt. of Lancaſhire, Cheſhire, &c.* p. 44. And in the following page and elſewhere he tells us, that by Nitrum Calcarium he means the bitter purging ſalt.

into the ciſtern, is from thence drawn, as occaſion requires, into the ſalt pan. Theſe pans are of the ſame form with thoſe uſed in boiling ſea ſalt; but leſs, uſually holding about eight hundred gallons [8]; and in Cheſhire are made of iron, but at Droitwich of lead. The ſalt pan being filled with brine, and the ſcratch pans placed at its corners, the fire is kindled, and ſome blood from the butchers is diſſolved in a little of the brine, and mixed with that in the pan, in order to clarify it [9]. (An ounce of blood, it is ſaid, will clarify eight hundred gallons of brine.) The brine, as ſoon as it boils, is ſkimmed; and afterwards ſuffered to boil violently, till the ſalt begins to form in it. The ſcratch is then all ſeparated, and the fire being ſlackened, it is ſuffered to ſubſide, and, when it hath all fallen into the ſcratch pans, they are then taken out of the

[8] At Inn'thalle in Tirol the iron pans, in which they boil their ſalt, are forty eight feet long, thirty four feet broad, and three feet deep.

At Salins they uſe iron pans of a round form, twenty eight feet in diameter, and fifteen inches deep. The practice of theſe foreigners is highly worthy the imitation of the Engliſh, as will be explained in another place.

[9] At Droitwich, and ſome other places, they clarify their brine with whites of eggs.

ſalt

ſalt pan. But when they boil brine of ſo great ſtrength as to be almoſt fully ſaturated with ſalt, they cannot conveniently clarify it, becauſe the ſalt begins to granulate before the brine boils; in that caſe, therefore, they mix no blood with it, but boil it briſkly for a little time, till all the calcarious earth and ocher are ſeparated; theſe mix with the ſalt then formed, and render it very impure; which is therefore raked out, and thrown away as uſeleſs. And this they call the firſt clearing of the pan [10].

IN either caſe, as ſoon as they have cleared the pan of ſcratch, and other impurities, and have brought the brine to ſuch a ſtate, that the ſalt begins to cryſtallize in it; they then uſually mix with it ale, butter, and other additions, or ſeaſonings, which they add, with a deſign either to correct ſome ſuppoſed faults of the brine, or to make the ſalt of a ſmaller grain, or for other purpoſes, of which it will be neceſſary to treat hereafter.

[10] When the brine was weak, they formerly filled up the pan two or three times with new brine, as in preparing ſea ſalt; but now they commonly heighten ſuch weak brine with rock ſalt.

These seasonings being well mixed with the brine, they boil it very gently during the rest of the process, and when as much salt is formed as will fill two or three of their large wicker baskets, they then rake it to the side of the pan, and fill it out into the baskets [11]; placing them over the leach-trough, that the leach-brine may drain into it from the salt. The salt taken out, they call a draught of salt, and the operation a clearing of the pan. And in this manner they draw the salt, and clear the pan five or six times in each process; leaving at last, only a few quarts of brine at the bottom of the pan, to keep it from burning. The whole process usually lasts about twenty four hours [12].

[11] These baskets, which are also called barrows, and usually contain about a bushel of salt, are of a conical figure, open at the base; see them rudely represented, together with the leach-troughs, hot-houses, &c. Plate VI. Fig. 1. and 2.

[12] And here it may be proper to take notice of Mr. Lowndes's laudable attempts for improving the English brine salt. And as he hath lately been induced by parliamentary encouragement to reveal his secret, I shall therefore here give his process in his own words; some of the advantages, as well as defects whereof, will be pointed out in the following sheets.

"Let a Cheshire salt pan (which commonly contains "about eight hundred gallons) be filled with brine, to

THE ſalt, after it hath drained for an hour or two in the baſkets over the leach-trough; is removed into the hot houſe, behind their furnace, where it remains four or five hours, till thoroughly dried and is then taken out of

" within about an inch of the top; then make and light " the fire; and when the brine is juſt lukewarm, put in " about an ounce of blood from the butcher's, or the " whites of two eggs: let the pan boil with all poſſible " violence. As the ſcum riſes, take it off: when the freſh " or watery part is pretty well decreaſed, throw into the " pan the third part of a pint of new ale, or that quantity " of bottoms of malt drink. Upon the brine's beginning " to grain, throw into it the quantity of a ſmall nutmeg " of freſh butter; and when the liquor has ſalted for about " half an hour, that is, has produced a good deal of ſalt, " draw the pan, in other words, take out the ſalt.

" By this time the fire will be greatly abated, and ſo " will the heat of the liquor. Let no more fewel be thrown " on the fire; but let the brine gently cool, till one can " juſt bear to put one's hand into it: keep the brine of " that heat as near as poſſible; and when it has worked " for ſome time, and is beginning to grain, throw in the " quantity of a ſmall nutmeg of freſh butter, and, about " two minutes after that, ſcatter throughout the pan, as " equally as may be, an ounce and three quarters of clean " common allum, pulverized very fine; and then inſtantly, " with the common iron ſcrape-pan, ſtir the brine very " briſkly, in every part of the pan for about a minute. " Then let the pan ſettle and conſtantly feed the fire, ſo " that the brine may never be quite ſcalding hot, nor " near ſo cold as lukewarm: let the pan ſtand working " thus for about three days and nights, and then draw it.

" The brine remaining will by this time be ſo cold, " that it will not work at all; therefore freſh coals muſt " be thrown upon the fire, and the brine muſt boil " for about half an hour, but not near ſo violently as

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baskets, and laid up in the store house for sale[13].

In all the English brine salt works, the liquor called leach brine, which drains from the salt in the baskets, or remains in the salt pan after the process is finished, is not thrown away as at the German salt works, and in the process of boiling sea salt; but is

" before the first drawing. Then, with the usual instru-
" ment, take out such salt as is beginning to fall (as
" they term it) and put it apart; now let the pan settle
" and cool. When the brine becomes no hotter than
" one can just bear to put one's hand into it, proceed
" in all respects as before; only let the quantity of
" allom not exceed an ounce and a quarter. And in
" about eight and forty hours after draw the pan."

This is Mr. Lowndes's process; only he afterwards directs cinders to be chiefly used in repairing the fires, the better to preserve an equal heat; and by that means also proposes to save a considerable part of the expence of fewel; asserting that " at present cinders are so little " valued in Cheshire, as generally to be thrown into " the highways." Mr. Lowndes informs us, that in a pan of the size directed by him to be used, there may be prepared at each process sixteen hundred pound of his salt, from the best brine in Cheshire; and 1066 pounds from the ordinary brine of that county. Which, as the process continues above five days, is little more than five bushels and a half of salt every day, from the best brine, and a little above four bushels a day from the ordinary brine.

[13] At Droitwich they make no use of hot houses for their large grained salt, but only let it drain in the barrows four or five hours, and then lay it up in their storehouses, which are lined on every side with boards, and have an inclining floor like drabs; and with this treatment it becomes sufficiently dry.

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constantly mixed with the next pan full of brine, and with it boiled into salt.

BESIDES the common salt prepared, as before related, at most of the English brine works, they make a salt which they call shivery salt, being of a firmer and larger grain than that prepared by the foregoing process, and also stronger and more proper for preserving provisions. In preparing this salt, they begin to work on Saturday night, proceeding exactly as in the foregoing process, 'till the salt begins to form. But as they draw no salt on Sunday, they therefore only keep a very gentle fire under the pan all that day, and so grain the salt with a much milder heat than at other times; taknig out the shivery salt all at one draught early on Monday morning.

THEY have also another kind of salt, made up like sugar loaves, in small wicker baskets, and therefore called loaves of salt, or basket-salt; which is greatly esteemed for table use, being the whitest salt, and perfectly dry, and of the smallest grain[14]. In preparing this salt,

[14] At Salins they put the wet salt, which they draw from the bottoms of their pans, into wooden moulds, in which they dry it in stoves, and thus form it into cakes or loaves weighing three or four pounds.

ſalt, ſome uſe roſin [15] and other additions to break the grain, and make it ſmall; and for the ſame purpoſe others boil the brine very briſkly, or keep conſtantly ſtirring it, whilſt the ſalt is forming. But the method moſt approved of in Cheſhire, is to proceed exactly as related in the proceſs for preparing common brine ſalt; and for baſket ſalt to take the ſecond and third draughts, which are eſteemed the pureſt ſalt. Theſe draughts they do not ſuffer to lie ſo long in the pan, as when they make ſalt of a larger grain, but take them out before the ſalt can concrete into large cryſtals; and by this means obtain a ſalt of a fine ſmall grain. This ſalt they preſs down hard into ſmall wicker baſkets, and when it is ſufficiently drained over the leach trough, remove it with the baſkets into the hot houſe; and after it hath been there well dried, carry it into the ſtore-houſe, and keep it in the baſkets for ſale.

[15] As at the works at Droitwich.

CHAP.

CHAP. III. SECT. II.

Of the additions, or ſeaſonings uſed by ſalt-boilers.

THE ſalt boilers, and particularly thoſe who prepare brine ſalt, have long been accuſtomed to make uſe of various ſubſtances which they call additions or ſeaſonings, and mix with the brine while it is boiling, either when they firſt obſerve the ſalt begin to form, or elſe afterwards during the time of granulation.

THESE additions they uſe for various purpoſes. As firſt to make the ſalt grain better, or more quickly form into cryſtals. Secondly, to make it of a ſmall fine grain. Thirdly, to make it of a large firm and hard grain, and leſs apt to imbibe the moiſture of the air. Fourthly, to to render it more pure. And laſtly, to make it ſtronger and fitter for preſerving proviſions.

THESE ends may ſome of them be anſwered by the additions made uſe of; but others, not; or at leaſt, might be better anſwered

ſwered by other means. So that ſeveral of theſe additions ſeem no way uſeful, but rather prejudicial. Neither is this to be wondered at; ſince this buſineſs is too often left to unſkilful operators, who will not eaſily be beat out of their old road; or if they make any new trials, are wholly ignorant of the nature of the ſubſtances they uſe, and apply them at a venture, without being able to form any conjecture of the effects which may be expected from them; and if perchance they prepare better ſalt than uſual, they immediately boaſt themſelves poſſeſſed of an extraordinary ſecret, attributing the alteration to the mixtures made uſe of, although it might often, with more reaſon, be aſcribed to the ſlowneſs or intenſeneſs of the fires, or to other circumſtances in the proceſs, to which they do not give a ſufficient attention.

The additions moſt commonly uſed to anſwer the above-mentioned purpoſes, are the following, viz. wheat flower, roſin, butter, tallow, new ale, ſtale ale, bottoms or lees of ale and beer, wine lees, and allom.

Wheat flower hath been uſed at ſome ſalt works to make the ſalt of a ſmall

grain [1]; which effect it may have, either by being interpoſed between the minute ſaline cryſtals, and ſo preventing their coheſion; or elſe by rendering the brine more glutinous, and ſo preventing the ſaline particles from moving towards each other, and uniting together ſo eaſily in that tenacious liquor as in a more fluid brine.

ROSIN hath long been held in great eſteem at the Droitwich ſalt-works, for its property of making their ſalt of a ſmall grain. And they are of opinion, that by means of this addition they obtain a whiter and finer ſalt, that meaſures farther, and is fitter for table uſe, than any that they could prepare without it. And in preparing baſket ſalt, they add a larger quantity of roſin than uſual [2]. The particles of roſin may probably interpoſe between the little cryſtals of ſalt, and prevent their coheſion. But all

[1] "If they would have it finer than it uſually corns "of itſelf, they either draw it with a quick fire, which "will break the corns ſmall, or ſprinkle the ſurface of "the brine with fine wheat flower, which will make "the ſalt almoſt as fine as the ſand which comes from "it." Plot *Nat. Hiſt. of Staffordſhire*, cap. ii. § 105.

[2] See Dr. Raſtel's account of the Droitwich ſalt works. *Ph. Tr. abr.* vol. ii. p. 358, 359.

They ſtill continue to uſe roſin at thoſe works.

addi-

additions applied for that purpoſe ſeem unneceſſary; ſince the ſame end may be better anſwered by drawing the ſalt before it hath lain long enough in the pan to form into large grains; eſpecially if the brine be ſtirred about, while the ſalt is forming; and the before-mentioned additions, as they render the ſalt impure, ought therefore to be rejected.

BUTTER, tallow, and other unctuous bodies are very commonly applied as additions; for the uſe of which many ſalt-boilers have little to plead beſides immemorial cuſtom. The reaſon which ſome of them give for uſing theſe unctuous ſubſtances, is, that they make the brine cryſtallize more readily; or, to uſe their terms, make it work or ſalt more kindly. And for this purpoſe, at ſome very large works, they think no fat ſo proper as that of dogs, if I was not much deceived by a ſalt-officer, who is eſteemed a man of integrity. Whether theſe ſubſtances have really the effects aſcribed to them, can only be determined by proper experiments. 'Tis however certain, that they have contrary effects upon ſome kinds of brine, both in England and Germany, and prevent it

from

from forming ſo readily into cryſtals[3]. And they were formerly uſed by ſeveral boilers of ſea ſalt, who now find that they can make as good ſalt without them[4]. 'Tis therefore moſt probable that theſe groſs unctuous bodies have much the ſame effects with roſin, by uniting to the ſaline particles, and with them forming a kind of ſoapy mixture, and ſo preventing, in ſome meaſure, their coheſion. When the brine is mixed with alcaline or calcarious ſalts, theſe unctuous ſubſtances may unite more readily to thoſe ſalts than to the common ſalt, and with them may form a kind of ſoap, and ſo may prevent them from being reduced into a ſolid form along with the common ſalt; and thus may preſerve it free from any mixture of ſalts of a different nature. But the Cheſhire ſalt-boilers, who make great uſe of butter, do not attend to theſe its effects, nor do they endeavour to preſerve

[3] "In coctione [ſalis] nihil accedere debeat quod "pinguedinem habet, alias ad ſolidam formam non po- "teſt facile reduci:" is a general rule of Hoffman's, *Obſ. Phyſ. Chem.* Lib. ii. Obſ. xvi.

[4] Theſe additions are now every where laid aſide at the marine ſalterns, except at thoſe at Lemington and other parts of the weſt of England, where they are ſtill in great repute.

their common ſalt pure from alcaline or calcarious ſalts, but harden all their leach brine into ſalt, as was before related. In which method theſe unctuous ſubſtances may, however, be of ſome uſe, by enveloping the alcaline and calcarious ſalts, and preventing them from diſſolving by the moiſture of the air; although the common ſalt would be much better, if entirely freed from this ſaponaceous mixture.

SEVERAL kinds of fermented liquors are alſo uſed as additions or ſeaſonings; the chief of which are, wine lees, new ale, ſtale ale, barrel bottoms, or lees of ale and beer. Theſe additions are now generally rejected by the marine ſalt-boilers, except in the weſt of England. The briners, who uſe them, affirm that they raiſe a large grain, and make their ſalt more hard and firm; and ſome alſo ſay that they make it cryſtallize or grain more readily. The Cheſhire briners uſe ſeveral of theſe liquors promiſcuouſly, as new ale and bottoms of ale[5], although they have very different qualities, and will probably have different effects upon the brine. Hoffman prefers the ſtrongeſt

[5] See Mr. *Lowndes's* proceſs.

and

and ſtaleſt ale[6]; and Plot aſſures us, that it makes the ſalt of a larger or ſmaller grain according to the degree of its ſtaleneſs[7]. And indeed, the only good effects that fermented liquors can have as an addition, are probably owing to their acid ſpirit, which may correct the alcaline ſalts of the brine, and ſo render the common ſalt more dry and hard, and leſs apt to diſſolve in a moiſt air. And to the conflict between this acid, and the alcaline ſalts of the brine, is probably owing the ebullition obſerved in the pan, when thoſe liquors are added. As to the effect which thoſe liquors can have of

6 "Coagulationem quoque promovet ſi non cerevi-
"ſia ſed zythus, aut Lobeiunſis cereviſia, quæ ſubacida
"eſt, aut quod melius adhuc eſt vinum, ſub coctione
"admiſcetur. Quinimo periculum feci, & inſtillavi
"rectificati vini ſpiritus unciam loco cereviſiæ, quo
"inſignem & notabilem immutationem ac coagulatio-
"nem animadverti, ſale candidiſſimo & admodum
"granoſo evadente. Spiritus enim vini egregie facit ad
"omnium ſalium cryſtalliſationem, eo quod unguino-
"ſam & unionem ſalinarum ſpicularum impedientem
"ſubſtantiam abſorbet, & ſalſas e liquore in fundum de-
"jicit particulas." Hoffman *De Salinis Hallenſ.* chap. vii.

The illuſtrious Mr. Boyle, from a ſaturated brine, precipitated a conſiderable portion of finely figured ſalt, by mixing it with dephlegmated ſpirit of wine. See Dr. Shaw's *Abb.* vol. i. p. 524.

7 *Nat. Hiſt. of Staffordſhire*, chap. ii. § 105.

promoting the granulation, it can only be very inconſiderable; and the beſt method of making ſalt of a large grain, is by means of a gentle heat, as will be more fully ſhewn hereafter. If therefore it ſhould be thought neceſſary to uſe any of theſe additions, in order to correct the alcaline quality of the brine, ſtale ale, or Rheniſh wine, ought to be choſen, for new ale contains but little acid; and the lees of malt drink will probably give the ſalt a diſagreeable taſte, and other bad qualities; eſpecially when theſe dregs are evaporated to a dryneſs, and hardened up with the ſalt, as is the practice in the common proceſs of making the Cheſhire brine-ſalt. And to theſe impurities, together with the ſaponaceous mixture of butter and alcaline ſalts, is probably owing the great abundance of thick froth or ſcum, which ariſes upon the ſolutions of ſeveral kinds of Cheſhire brine and refined rock ſalts; and which I did not obſerve upon the ſolutions of ſome kinds of boiled ſea ſalt, in the preparation of which none of theſe additions were uſed.

Allum is an addition which was long ago known in Cheſhire, and there uſed, together with butter, to make the ſalt precipitate

pitate from ſome ſorts of brine, as we are aſſured by Dr. Leigh[8], who firſt taught the Cheſhire ſalt-boilers the art of refining their rock ſalt. 'Tis indeed probable, that they formerly tried many methods in order to correct the bad qualities of their ſalt, and to render it ſtrong, and of a large grain, and ſufficiently firm to endure the air. But as the bad properties of their ſalt proceeded from hard boiling, they found every method ineffectual, until they had recourſe to a more mild and gentle heat. And as allum hath long been diſuſed amongſt them, it is not likely that they found any extraordinary benefit from it; otherwiſe they would ſcarce have neglected it, and continued the uſe of butter. However, a Cheſhire gentleman hath lately endeavoured to revive its uſe, aſſerting, that "brine-ſalt hath evermore "two main defects, flakeyneſs and ſoft-"neſs; and that to remedy theſe imper-"fections he tried allum, which fully an-"ſwered every thing he propoſed; for it

[8] "It is obſervable the ſalt of ſome of theſe ſprings "will not eaſily precipitate, but a little allum and freſh "butter will effect it; and then it makes a larger grain "and ſtronger ſalt than any of the reſt." Dr. Leigh's *Nat. Hiſt. of Lancaſhire, Cheſhire, &c.* (publiſhed at Oxford in the Year 1700) p. 44.

" reſtored the ſalt to its natural cubical " ſhoot, and gave it a proper hardneſs, nor " had it any bad effect whatever[9]." But whoever conſiders the nature of allum will ſcarce expect ſuch extraordinary effects from it. Neither does it here ſeem wanted; for the grains of common ſalt will always be ſufficiently firm and hard, and of their natural figure, and of a large ſize, and no ways diſpoſed to run by the moiſture of the air, if formed by a gentle heat, and perfectly free from heterogeneous mixtures, as will be more fully explained hereafter. So that the goodneſs of the ſalt made by that gentleman, does not ſeem to be owing to the allum, with which it is mixed; but may be attributed, chiefly to the gentle heat uſed in its preparation.

The Dutch, who have long ſhewn the greateſt ſkill and dexterity in the art of boiling ſalt, make uſe of another addition, which they eſteem the greateſt ſecret of their art. This is whey, kept ſeveral years, 'till it is extremely acid; now firſt revealed to the Britiſh ſalt boilers; but long held in great eſteem by the Dutch, for the good

[9] See Mr. Lowndes's treatiſe intituled, *Brine ſalt improved*, p. 13.

effects

effects it hath upon their ſalt; which it renders ſtronger and more durable, and fitter for preſerving herrings, and other proviſions[10]. 'Tis certain, that this acid liquor may temper the mineral alcaline ſalts mixed with their brine; and may alſo reduce into a mild neutral ſalt the alcaline principle of common ſalt, deprived of its acid ſpirit by the violent coction uſed in the firſt part of the Dutch proceſs, as will be related hereafter. The unctuous particles of this whey may alſo entangle the calcarious ſalts of the brine, and contribute to retain them the better in the bittern, and ſo prevent any of them from forming into cryſtals along with the common ſalt. And this whey, being itſelf a mild acid condiment, can be no ways prejudicial to the common ſalt, if mixed with the brine in ſuch quantities, as to be predominant over the alcaline ſalts contained therein.

[10] The manner in which the Dutch uſe this addition, ſee related in chap. vii. of this part.

CHAP. IV.

Of white ſalt prepared from ſea water, and other ſalt waters, firſt heightened into a ſtrong brine by the ſun.

IN ſeveral inland parts of Germany, where they have only weak ſprings of ſalt water, and alſo at many places on the ſea coaſts of England where fuel is ſcarce, various artifices have been invented for converting thoſe ſalt waters into a ſtrong brine, which they afterwards boil with culinary fires into white ſalt.

SOME have expoſed thoſe ſalt waters in open veſſels to be congealed in part into ice; and as the water freezes, the ſalt is in a great meaſure expelled out of it into the uncongealed liquor; which thus, during hard froſts, is converted into a ſtrong brine[1].

BUT the ſame effect is with greater convenience and certainty performed by the heat

[1] "Nonnulli ſalſilaginem frigori exponunt, atque "gelari ſinunt, & aptiſſima eſt huic ſcopo illa, quæ duas "aut unam cum dimidia ſalis uncias comprehendit (ſcil. "in ſalſilaginis lib. i.) quæ enim tres, quatuor, aut quin-"que uncias cuſtodit, nunquam frigore denſatur: di-"midia vero, aut una uncia fœta, tota in glaciem abit." Hoffman *De Salin. Hall.* chap. vii.

heat of the ſun, and the operation of the air. For this purpoſe, in ſeveral parts of Germany they erect ſumptuous edifices of wood. One of which works at Soda, near Frankfort on the Main, with the method of preparing brine therein, is deſcribed by an ingenious traveller, in the following words[2]:

"IT belongs to Mr. Malapert, and has "been wrought above ſixty years.---There "riſes at the foot of ſome little hills which "produce very good wine, a ſpring of wa-"ter that is ſo very little brackiſh to the "taſte, that one will hardly think it poſſi-"ble to fetch much ſalt out of it, yet it has "ſuch a taſte of ſalt, that there was room "for induſtry to prepare this water ſo, that "without ſuch an expence of fire as would "eat out the profit, it might turn to a good "account.---The meadow that lies in the "level with this ſpring is impregnate with "ſalt, iron, nitre, and ſulphur, but ſalt is "that which prevails. Firſt then, a pump

[2] See *Supplement to Biſhop Burnet's Letters.* Letter iii.

Theſe the Germans call Leck-oder Gradier-wercke, and have many of them; but they are not all conſtructed alike; for where the water is ſalter, they have fewer ciſterns; in ſome works only one, as at Bevieux or Roche, as hath before been related.

is

" is put upon this ſpring, which is managed
" by a water-mill, and throws up the wa-
" ter about fifteen feet high; and then it
" goes by a pipe into vaſt machines, that
" are made to receive it.

" There is a great piece of ground in-
" cloſed, in which there are 24 vaſt cheſts
" or ciſterns for the water, in two ſtories,
" twelve in a ſtory, the one juſt over the
" other; they are about ſeventy foot long,
" twelve broad, and two deep; over every
" one of theſe there is a roof of boards ſup-
" ported by wooden pillars twelve foot high,
" which covers them from rain-water, but
" yet the water within them is in a full
" expoſition to the ſun; thoſe roofs are
" hung with ſtraw, upon which ſome that
" manage the work are often throwing up
" the water, ſo that a great deal of the
" phlegm is imbibed by the ſtraw, and the
" more fixed parts fall down. According
" to the heat of the ſeaſon, this evapora-
" tion of the watery parts goes quicker or
" ſlower. There is a gage, by which they
" weigh the water, and ſo they know how
" the evaporation advances; it is of ſilver,
" and is ſo made, that according to the
" weight of the water it ſinks into it to
" ſuch

" ſuch a depth, and ſo by the degrees
" marked upon it they know how heavy
" the water is. According then to the heat
" of the ſeaſon, and the progreſs of the e-
" vaporation, they let the water out of one
" ciſtern into another, by a pipe; and
" when it hath paſt through the twelve
" that are in the upper ſtory, then it is
" conveyed down by pipes into the twelve
" that are below; and in them all they con-
" tinue ſtill to throw up the water upon
" the withs of ſtraw that are over head.

" IN a word, this evaporation diſcharges
" the water of ſo much of its phlegm,
" that the ſame quantity of water that
" weighed one ounce, when it was drawn
" from the ſpring, weighs ſix ounces in
" the laſt cheſt[3]. And all this rolling about
" of the water from cheſt to cheſt laſts
" ſometimes not above twenty days; but, if
" the ſeaſon is only moderately hot, it will
" be longer a-doing: ſometimes it will not
" be done in a month's time[4]. After that

[3] This is certainly an error; he probably means that only one ſixth part of the water remains, the reſt being evaporated from the ſalt.

[4] Hoffman, ſpeaking of this method, ſays, " Totum " negotium minus exoptato ſuccedit, niſi ſiccitas per

" the

" the water is brought to a very confide-
" rable degree of faltnefs, it is conveyed
" into two great caldrons that are thirteen
" foot long, ten broad, and three and an
" half deep, under which there are vaft
" furnaces, where, in a moft violent fire of
" eleven or twelve hours, the water receives
" its laft evaporation; and when that is
" done, the falt, which is become thick,
" but is ftill moift, is taken up in bafkets
" of willows, and placed about the wall of
" the furnace, fo that the humidity that
" remains in it drops out, and it is brought
" to its laft degree of perfection.---There
" are vaft quantities made of it in hot and
" dry fummers, for the chefts are kept al-
" ways full; and thus all Franconia is fur-
" nifhed with falt of its own production, at
" very moderate rates."

But the Englifh elaborate fea water into brine by a much eafier and lefs expenfive method than that before defcribed. This is called raifing or heightening fea water by the fun; and there are many large works at Lemington in Hampfhire, and in the ifles

" annum regnet, & commodiffime tantum adornatur
" vento boreali & orientali fpirante, vernali atque æfti-
" vo, non autem hiemali tempore.

of

of Wight and Portſea, alſo about Pool in Dorſetſhire, and nigh Topſham in Devonſhire, where this method hath long been practiſed, to the great advantage of the proprietors of thoſe works; who though they boil their ſalt with Newcaſtle coal, yet can afford to ſell it cheaper at London than that which is boiled from ſea water in the neighbourhood of Newcaſtle; where the coal does not coſt above a quarter part of the price paid for it by the owners of thoſe ſalt works in the weſt of England.

THE works in which the ſea water, is heightened into brine, are called ſun-works, or the out-works; and are conſtructed nearly after the following manner[5].

A PROPER ſituation, on a flat downs, or ouzy beach is choſen, from which, if there,

[5] The account here given is the beſt that I have been able to obtain, having been compoſed from the relations of ſeveral ſalt-officers, compared with a few hints, which Mr. Brown, Harris, Chambers and others have given us relating to theſe works. I am very far from offering this as a perfect and exact deſcription; but as one from which an idea may be formed of the general contrivance of theſe works. It is to be wiſhed that ſome perſon of publick ſpirit would favour us with a more perfect account of them; which was much deſired by the Royal Society ſixty or ſeventy years ago.

be

be occaſion, the ſea is barred out by a mole. Within this mole, there is a large reſervoir or feeding pond, which has a communication with the ſea by a ſluice; and adjoining to the reſervoir, a long trench; and parallel to the trench ſeveral ſquare ponds, nine or ſometimes twelve in number, all placed in a row, the whole length of the trench; and parallel to this row, two other rows of ſquare ponds, equal to thoſe in the firſt row in number and dimenſions. Theſe ponds they call brine pits. Beyond the third row, is a row of larger ponds three in number, with each of which, three or four of the brine pits in the third row communicate by narrow openings. Theſe they call ſun pans; and theſe three ſun pans often communicate with another larger pond, which they call the common ſun pan, from which the brine flows into large covered ciſterns (made very tight of brick and clay) adjoining to the boiling houſe. All theſe ponds, with the partitions between them, uſually cover about two acres of ground.

The bottoms of the ponds, are in ſeveral places, as at Lemington, made of an ouzey mud; to make which hold water, they tread it down very hard with boots that

that have flat ſoles, and afterwards lay it very ſmooth, and in the brine pits and ſun pans, cover it with ſea ſand; which prevents the ouzey bottoms from cracking when dry, and makes them better retain the ſun's heat, and more readily exhale the watery vapours. The bottoms of all the pits form an inclined plane, which is higheſt at the reſervoir, and loweſt at the common ſun pan; but where the ground will not admit of ſuch a declenſion, the water is raiſed up by a ſcoop and trough, which turn upon an axis; and the ſcoop receiving the brine from the lower pond, when it is raiſed up, it falls into the trough, through which it runs into the higher pond adjoining. The partitions between the ponds are all of mud and earth, a foot and an half or two feet broad, and have little openings by which the pits communicate one with another; and theſe openings are cloſed with mud, when occaſion requires.

THE ſea water being received into the reſervoir at full ſea, is from thence let out, as occaſion requires, into the trench; and from the trench, into the firſt row of brine pits; and when they are filled to a certain height, the openings between them and the trench are dammed up with mud. When the water hath ſtood a due time in this firſt row of

pits, it is let out into the ſecond row, which before were empty, and the bottoms of them expoſed to the heat of the ſun. After a certain time, which is longer or ſhorter in proportion as the evaporation advances, the brine is let out of the ſecond into the third row of pits; and about the ſame time the firſt row of pits are again filled; the ſeveral rows being thus emptied and filled alternately. When the brine is ſufficiently evaporated in the third row of brine pits, it is ſuffered to flow into the ſun pans; and afterwards into the common ſun pan; where they examine its weight by means of glaſs hydrometers; and when they find it of a due ſtrength, they draw it from thence into the ciſterns; where it is ſtored up till they have an opportunity of boiling it.

THE ſea water, which was received into a row of the brine pits, and carried forward together through the whole work, is called a courſe of brine. And ſometimes when the weather is exceſſive hot, it is brought to its full ſtrength, and performs its whole courſe from the trench to the ciſtern in twenty four hours. But when the weather is leſs favourable, it requires a much longer time for its paſſage. And ſometimes, when they obſerve ſhowers

ſhowers approaching, they draw it off into the ciſtern before it is brought to its full ſtrength. In this courſe the ſalt water ſtands deepeſt in its firſt row of brine pits, and gradually ſhallower in the ſeveral pits, till it arrive at the ſun pans, where it ſtands ſhalloweſt; in the common ſun pan it is ſix or ſeven inches deep, being there deeper than in the ſmaller ſun pans.

AND after this manner, if the ſeaſon prove favourable, they make as much brine as keeps them boiling till nigh Chriſtmas; after which they repair their pans and furnaces, and prepare their Epſom ſalt from the bittern, and begin again to make brine about April.

THE pans in which they boil the ſalt at Lemington are of lead, of a ſquare form, and ſmaller than thoſe before deſcribed for boiling ſea water into ſalt. They uſually have four of theſe pans in a ſaltern, all placed in a row, with a diſtinct furnace to each of them. The chimnies are carried up by the ſide of the wall, which divides the boiling houſe from the forehouſe; and the ſmoke is conveyed from each furnace into theſe chimnies by two flues, one on either ſide of the mouth of the furnace. To each of theſe flues is fitted a regiſter, or plate of iron,

placed horizontally, which, by means of a handle, may be drawn out, or thruſt in over the flue, ſo as to cloſe it and prevent the ſmoke from aſcending through it. And by means of theſe regiſters, and vent-holes, and doors to the mouths of the furnaces and aſh pits, they can regulate the fires in the exacteſt manner, and can damp them while the ſalt is graining, or ſmother them quite out, if they ſee occaſion.

In the boiling houſe they have a chimney to convey off the vapours from each pan; it is a ſquare funnel of boards, which is not carried down ſo low as the pan; but room is left below it for the ſalt-boilers to draw the ſalt, or to do any other buſineſs about the ſalt pan. There is only one long walk in the boiling houſe, on the ſide of the pans oppoſite to the mouths of the furnaces; and between this walk and the wall, are placed large wooden troughs, with many little holes in their bottoms; into which troughs the ſalt, when drawn out of the pans, is put to be drained from the bittern. Below theſe troughs others are placed to receive the bittern; and in them ſeveral ſticks are fixed erect, to which the cat ſalt adheres in large

cryſtals;

cryſtals[6]. This (as I am informed) is the general conſtruction of the Lemington ſalt-erns, which ſeems very artful and commodious.

THE proceſs for boiling ſalt is much the ſame here as at the brine works. Only it may be proper to mention a few particulars in which there is a difference. And firſt, at the Lemington works they uſe no clarifying mixtures, which are there unneceſſary, as the brine commonly ferments in the ciſterns, and by that means the texture of its viſcuous matter is broken, the more groſs parts whereof, together with the light mud, ſubſide to the bottom of the ciſtern. They boil the brine violently till a thin ſkin of ſalt appears on its ſurface[7]; and then damp the fire, and carefully ſkim off this ſkin, and alſo take out the calcarious earth and caſt it away. This earth they do not collect into ſcratch pans, as at moſt other works, but ſuffer it to ſettle to the bottom of the pan, and rake

[6] The cat-ſalt is common ſalt, which concretes round theſe ſticks in large clear lumps; it holds ſome of the bitter purging ſalt; it is very ſharp and pungent; and, when powdered, white; and is uſed by ſome for the table; but the greateſt conſumption of it is among the cake ſoap-boilers.

[7] They ſay then that the brine begins to yew.

it to the ſide, and thence draw it out. The brine being cleared from the ſcratch, they then add to it butter, and other ſeaſonings; and afterwards proceed to grain the ſalt with moderate fires, although they grain it more haſtily here than at moſt works, commonly reducing three pans full of brine into ſalt in twenty four hours. When the ſalt hath remained in the troughs ſix or ſeven hours, it is taken out; and, without any other preparation, laid up in the ſtore houſes for ſale[8].

[8] A ſalt-boiler with an aſſiſtant attends four pans, and alſo prepares the brine in the out works. The ſalt-boiler for wages receives 1 *s.* 6 *d.* per quarter, or ſix ſhillings per tun for all the ſalt made; out of which he pays the aſſiſtant. Of this they reckon 10 *d.* per quarter for boiling the ſalt, and 8 *d.* for preparing the brine. They can afford to ſell the ſalt at theſe works, free of exciſe, from 1 *l.* to 1 *l.* 6 *s.* per tun, according as the ſeaſon has been more or leſs favourable for making it, or according as there is a demand for it. Whereas at Newcaſtle the profit is very ſmall, when they ſell their ſalt for 30 *s.* per tun; although it is ſometimes ſold there for 27 *s.*

CHAP. V.

Of white ſalt made from a ſtrong brine drawn from earths, ſands, and ſtones impregnated with ſalt.

THE ſtrong brine or lee which is drawn from ſaline earths, ſands, and ſtones [1], and afterwards boiled into ſalt, is prepared after different ways.

IN ſeveral parts of Germany, as at Inn'thall [2] nigh Inſpruck in the county of Tyrol, and at Halleim in the archbiſhoprick of Saltsburgh, alſo at ſeveral places in the Upper Auſtria, there are deep mines, in which they dig ſalt mixed with much mud and earth. This impure ſalt, or ſaline earth, they do not draw out of the mines, but break into pieces, and caſt it into pits at the bottom of the mines; theſe pits they fill up with water, and when the water has ſtood

[1] Brine prepared in this manner is called Dilutum by Agricola.

[2] The mines are ſaid to be four miles diſtant from the city, and the brine is conveyed all that way through troughs, to the ſalterns. At theſe works, when Mr. Addiſon was there, they made at the rate of eight hundred loaves of ſalt a week; each loaf being four hundred weight.

in them ſome weeks, it becomes a fully ſaturated brine, each pound of it having abſorbed ſix ounces of ſalt. This ſtrong brine is then drawn out of the mines, and conveyed through wooden channels to the ſalterns, and boiled in iron pans into white ſalt, for which they find a ſale in Bavaria, Stiria, Carinthia, and in ſome of the Swiſs cantons, and amongſt the Griſſons[3].

In other places they do not dig out the ſaline earths and ſtones, but introduce freſh water into the places where they are lodged, and the water being impregnated with the ſalt is thence drawn out, and evaporated in proper veſſels[4].

[3] Vide Hoffman *De ſalinis Hallenſ.* Cap. ii. et iv. Et *Obſ. phyſ. chem.* Lib. ii. Obſ. xvi.

"On voit auſſi dans l'Auſtriche ſuperieure, au lieu "appellé Mund, (où il y a des montagnes, qui ont des "veines remplies de ſel) de ſomptueux edifices de bois, "pour conduire les eaux inſipides dans les endroits où "eſt ce ſel, afin que la diſſolvant, elles en prennent le "gout." Comte Marſilli, *Hiſt. de la Mer*, p. 22.

[4] A French traveller takes notice that the waters at Roche are inſipid before they paſs over veins of ſalt, whereof they inſtantly take the acrimonious ſavour. The galliery cut through a rocky mountain for the paſſage of this ſalt water to the ſaltern, he ſays, is five hundred fathoms in length.

Saxa ipſa (in putei cuniculis, magno labore exciſis) ſalinis particulis referta; quæ indicio ſunt manifeſto eſſe ſal hoc Bactiacum foſſile, ab aqua fontana ſolutum, rurſumve arte concretum. Scheuchzeri *Iter Alpin. ſeptimum*, on the ſame ſalt works.

In

IN other places a ſtrong brine is extracted from ſea ſand; which brine is afterwards boiled into white ſalt. There are very conſiderable works of this kind at Mount St. Michael, and other places upon the coaſts of Normandy; where this ſalt is made ſo cheap, that it is often exported to London; although loaded at that market with a heavier duty than Britiſh ſalt. There were formerly ſeveral works of the ſame kind at Wire-water, and Medop in Lancaſhire, and at Milthorp in Weſtmoreland; at which places, pit-coals being ſcarce, they boiled the ſalt with turf fires; but ſince brine ſalt, and refined rock ſalt have been made in ſuch plenty in Lancaſhire and Cheſhire, all thoſe ſand works have gone to decay; and that method is, in thoſe parts, intirely laid aſide; except at one or two very inconſiderable works nigh Ulverſtone in Lancaſhire.

THE ſand from which they prepare the brine at the works nigh Ulverſtone, is collected on flat ſandy ſhores, on thoſe parts of them which are only covered with ſea water in the high tides which flow two or three days before, and three or four days after the full and new moon; for thoſe parts of the ſands which are overflown by the

neap tides, are ſeldom ſufficiently dried, and are at too great a diſtance from the ſalterns.

THIS ſand they collect in flats and waſhes, or in parts of the ſands which are perfectly plain, and in little hollows where the ſea water is left, and either ſinks into the ſand, or is dried up by the heat of the ſun, leaving the ſalt behind. The ſand is only collected in dry weather, when the ſea water hath been exhaled from it by the ſun, and the rains have not waſhed the ſalt out of it. At ſuch times, and in ſuch places they rake up the ſand into heaps, to the depth of two or three inches, and convey it to their works in carts; laying it up in a large heap, where it is expoſed to the weather, and ſubject to be much injured by rains. They therefore work it up with all diligence, and rarely boil any ſalt in the winter ſeaſon.

IN order to extract the ſalt from the ſand; adjoining to the ſaltern, they dig a pit eighteen feet long, three feet broad, and one foot deep. The bottom of this pit they cover with ruſhes, or ſtraw, and then fill it up with the ſalt ſand from their heap; upon the ſand they pour ſea water, which they take into a pond or ſump at ſpring tides;

the

the water imbibing the ſalt from the ſand, filtrates through the ruſhes or ſtraw, and runs through a pipe from the bottom of the pit, into a ciſtern placed in the boiling houſe. They continue pouring ſea water upon the ſand, ſo long as the brine in the ciſtern will bear a hen's egg to a certain height. And thus having extracted moſt of the ſalt from the ſand, they remove it, and fill up the pit with freſh ſand from their heap.

THE brine being thus prepared, they boil it with turf fires in ſmall leaden pans; in which they only make about two gallons of ſalt at each proceſs, which is uſually performed in four hours. They uſe no clarifying mixtures, but take off a ſcum, which ariſes in great plenty when the brine begins to boil[5]. They drain their ſalt in wicker baſkets, which they hang up in the hotteſt part of the ſaltern. After each proceſs, they throw out the bittern that remains in the pan; and about once a day, while the pan is hot, remove it from the fire, and beat it with a wooden mallet, and thus free

[5] We are told that in Normandy, while the ſalt is graining, they ſtir it continually with wooden ladles.

it from the calcarious cruſt which adheres to its bottom and ſides[6].

CHAP. VI.

Of refined rock ſalt.

THE practice of refining rock ſalt, and converting it into white ſalt, hath long prevailed in ſeveral countries, particularly in Great Britain, Hungary, and Poland.

THE Cheſhire foſſil ſalt is eſteemed unfit for domeſtic uſes, untill it hath undergone this preparation[1]. Vaſt quantities of it are now refined in that county, being firſt

[6] This ſhews that Dr. Liſter was miſtaken in ſuppoſing, that the ſcratch was formed by boiling the brine in iron pans; becauſe he obſerved none in the Droitwich brine, which was boiled in lead pans.

[1] We are informed in the *Philoſophical Tranſactions*, that the mines out of which this ſalt is dug, were firſt diſcovered in the year 1670, in boring for coals in the liberties of William Marbury of Marbury, Eſq; where it lay thirty-three or thirty-four yards from the ſurface, and that from it there iſſued a vigorous ſharp brine, ſtronger than any then uſed in Cheſhire.

At preſent many mines of this ſalt are wrought nigh Northwich, by ſeveral proprietors, moſt of whom are united in one company for the more convenient carrying on of their works.

diſſolved

diſſolved in weak brine[2]. Large quantities of it are alſo carried in boats down the rivers Weever and Merſey; and either refined at Dungeon and Leverpool, where they take up ſalt water out of the river Merſey at full ſea, to diſſolve it in; or elſe ſhipped at Leverpool, and tranſported by ſea along the Britiſh coaſts, and into Ireland, to places where it is boiled into white ſalt with ſea water[3].

THE works where they boil rock ſalt are called refineries; at thoſe works at Dungeon and Leverpool, the rock ſalt is broken ſmall, and thrown into leaden ciſterns, and there diſſolved cold in ſea water. In theſe ciſterns

[2] The refined rock and brine ſalts are exported from Leverpool in very large quantities to many parts of Great Britain and Ireland; and alſo to the American colonies, more eſpecially ſince the commencement of the preſent war, whereby the inhabitants of thoſe colonies have been prevented from ſupplying themſelves with ſufficient quantities of bay ſalt.

White ſalt is uſually ſold at Leverpool for about one Pound per tun, excluſive of the duty.

[3] It was provided by act of parliament, that no rock ſalt ſhould be refined at any works in Great Britain, diſtant above ten miles from the mines where it is got, except at ſuch works where it was refined before the ſaid act took place. By another act, a large duty was laid upon rock ſalt exported to Ireland; but the time for which that duty was impoſed being expired, and the act not renewed, many refineries have lately been erected in that kingdom.

ciſterns the ſtrong ſolution remains twenty-four hours to ſettle, and is then craned off from the ſediment into the ſalt pan, and there boiled into ſalt, as is practiſed with natural brine, it being clarified in the ſame manner, and mixed with the ſame additions. During the proceſs, large quantities of ſcratch fall from it, as from natural brine.

The leach brine is not thrown away as at the marine ſalt works, but is preſerved and mixed in the pan with the ſolution of rock ſalt, and with it boiled up, as at the Cheſhire brine works.

CHAP. VII.

Of the Dutch method of preparing ſalt upon ſalt.

IN Holland and Zealand, the Dutch for ages paſt have practiſed the art of refining ſalt with the greateſt ſucceſs; and to their extraordinary ſkill in this art, are in a great meaſure owing the advantages which they have over other nations in the herring fiſhery; ſince fiſh preſerved with their refined ſalt, look much cleaner and fairer than thoſe that are cured with bay ſalt, and keep much

much better than thoſe preſerved with any other kind of white ſalt. And although inquiries into this art ſeem of great importance to a trading maritime nation, yet they ſeem to have been almoſt wholly neglected by my countrymen; or if any of them have got a knowledge of this art, they have concealed it out of views of ſelf-intereſt, or other private motives.

BUT as I am perſuaded, that a more general knowledge of this art may be of public uſe, and being under no tie of ſecrecy; I ſhall therefore act in this as I have done in all other caſes, and faithfully reveal ſuch particulars relating to this art, as I found means of obtaining during my reſidence in Holland, from ſeveral perſons of credit, who had the beſt opportunities of informing themſelves about it.

THE Dutch prepare two kinds of refined ſalt; the one of a ſmall grain for table uſe, which they call butter ſalt, and export in large quantities up the Rhine, and into other parts of Germany. The other ſort is a very ſtrong pure ſalt, of the largeſt grain of any boiled ſalt now made; and this they call Saint Ubes or Liſbon ſalt; from its reſemblance

ſemblance to the pure bay ſalt brought from thoſe places.

The ſalt which they refine is altogether marine bay ſalt; which they have chiefly from France and Spain. As from Rochelle, Souſton nigh Bayonne, and Cadiz[1]. They find by experience, that any one kind of bay ſalt does not anſwer their purpoſe ſo well as ſeveral kinds mixed. They therefore frequently mix three parts of Spaniſh ſalt with one of that of Souſton; which laſt is much eſteemed for its great ſtrength, but is very dirty, and of a bad green colour, and does not coſt above half the price of the Spaniſh ſalt; however, they eſteem a certain proportion of it neceſſary, but are obliged to uſe it ſparingly; for the operators affirm that more than a quarter part of it would render the refined ſalt, black and unfit for ſale.

For diſſolving the bay ſalt they uſe ſea water, which they bring to Dort and Rotterdam in large lighters from below the Briel or Helvoet. Out of theſe lighters it is craned into cellars, where it is impreg-

[1] For ſome time indeed they uſed conſiderable quantities of the Engliſh rock ſalt; but I am informed that the uſe of it was prohibited by the States; who found that the ſalt which they prepared with it was not ſo good as the refined bay ſalt.

nated with the bay ſalt to a certain degree of ſtrength, of which they judge by hydrometers made for that purpoſe.

AFTER the heavy droſs of the ſalt hath ſettled to the bottom of the cellar, the clear brine is pumped up into the ſalt pan through a mat, which retains the light ſcum, ſtraws, or other impurities which ſtill may float therein.

THEIR ſalt pans are made of iron, commonly of a round form, and of an extraordinary magnitude; being uſually forty feet in diameter, and eighteen inches deep; and are bound round very ſtrongly with large bars of iron[2].

THESE pans are placed over a hearth furnace. The fuel which they burn in theſe furnaces is altogether turf, which they endeavour to procure as dry as poſſible; wet turf being found to corrode their pans, and to make them conſume more quickly than that which is dry[3].

[2] I have been told, that, when theſe pans are new, they waſh them over with lime and water, which preſerves the pan from ruſt, and never wears off. But it ſeems more probable, that they only fill up the joints with lime, as we do in England.

[3] It hath been reported, that the Dutch uſe pit-coal at their ſalt works. It is true indeed, that for all works where pit-coal is neceſſary, as for light-houſes, glaſs-

THE

The pan being filled with brine, and the fire kindled, the brine is made to boil violently, and if any ſcum ariſes they take it off, but do not uſe any clarifying mixtures[4].

A LITTLE before the ſalt begins to form, they ſlacken the fire, and add to the brine the bigneſs of a walnut of the freſheſt butter[5], and half a pint of their ſour whey before deſcribed, taking care to ſtir it well about, that theſe ſeaſonings may be every where equally mixed with it. They then ſhut up the doors and windows of the ſal-

houſes, ſmiths forges, the States wiſely encourage the importation of pit-coal, and ſuffer it to be uſed duty free. By which means the Dutch manufacturers have thoſe coals cheaper at ſuch works than the Engliſh, when only carried from one of our ports to another. But the caſe is different when pit-coals are uſed in Holland for common fires, or in works where they are not abſolutely wanted; for then they are loaden with a heavy duty, in order to prevent the conſumption of a foreign commodity. And, as in refining ſalt, the Dutch chiefly apply ſlow and regular fires, turf ſeems as proper for that uſe as pit-coal. It is therefore moſt likely, that agreeably to the wiſe policy of their government, and the informations which I have received, the Dutch, in refining ſalt, uſe fires of turf, which is the product of their own country.

[4] One gentleman informed me, that they clarified with whites of eggs, but two of the Dutch ſalt boilers aſſerted the contrary.

[5] I have reaſon to ſuſpect that the butter is added only when they make their table ſalt, which they call butter ſalt.

tern,

tern, ſo that no freſh air can blow into the pan; and the houſe becomes very hot; and is thus kept cloſe all the time that the ſalt is graining [6].

IF they make table ſalt, the brine is ſuffered to ſimmer gently during the granulation, and the whole proceſs is finiſhed in twenty-four hours.

BUT when they make their ſtrong ſalt for curing proviſions, they only uſe an extremely mild and gentle heat, ſo that three days are uſually ſpent in the proceſs, before the brine is ſufficiently evaporated.

IN both caſes, they ſuffer the ſalt to remain in the pan 'till the proceſs is finiſhed, and then rake it to the ſides with wooden rakes, the handles of which are twenty feet long. It is then taken out, and, after the brine hath drained from it in wooden drabs, it is fit for uſe [7].

[6] At many of the German ſalt works, where they boil brine ſalt, they alſo exclude the cold air from the pan, while the ſalt is graining, by boards placed on every ſide of it, after the manner directed by Agricola.

[7] The table ſalt is uſually ſold at the works for about twenty-four ſtyvers, and the ſtrong ſalt for about thirty ſtyvers the buſhel; and their buſhel is ſaid to contain about fifty pounds of the table ſalt; and eighty pounds of the ſtrong refined ſalt. There is probably a greater duty upon the table ſalt than upon the ſtrong refined ſalt, which makes the latter cheaper than the former.

The mother brine, of which there remains a large quantity in the pan after the ſtrong ſalt is made, as alſo that which drains from the ſalt in the drabs, is reſerved to be boiled up for table ſalt, being never uſed in preparing the ſtrong ſalt.

But the mother brine of table ſalt, after each proceſs becomes more ſharp and bitter; and is therefore, at certain times, thrown out as uſeleſs; great care being taken to waſh it well out of the pan before they propoſe to make their ſtrong refined ſalt.

APPENDIX

To the foregoing

HISTORY.

CHAP. I.

Of the qualities of the ſeveral kinds of bay ſalt.

HAVING, in a brief manner, related the various methods of preparing ſalt, as now moſt commonly practiſed; it will in the next place be neceſſary to ſubjoin a ſhort account of thoſe qualities, which ſalt acquires chiefly from the different ways of preparing it; that ſo, thoſe methods may be choſen by which a ſalt is made moſt proper for the uſe of the table, or for preſerving proviſions; and thoſe methods may either be amended or rejected, by

by which a ſalt is prepared leſs fit for the abovementioned purpoſes.

And firſt; the ſeveral kinds of bay ſalt differ from each other, chiefly in the following particulars, viz.

1. *In the ſize of their cryſtals.* For bay ſalt, in proportion as it lies a longer or a ſhorter time in the pits, or as the ſolar heat, or force of the air is more or leſs powerful, will be formed into greater or ſmaller cryſtals. Upon theſe accounts the French cream of ſalt, and the blown ſalt of the Iſle of May, which are ſkimmed off the ſurface of the brine, are of the leaſt grain. The Portugal ſalt is commonly of a larger ſhoot than that of France; and that of Tortuga, much larger than that of Portugal.

2. *In purity.* For there is ſcarce any bay ſalt which is not mixed with ſeveral heterogeneous ſubſtances; as ſlime, mud, ſand, and clay, which are raked up with it from the bottom of the pits where it is made, or mixed with it whilſt it lies on the ground in heaps. There are ſome kinds of bay ſalt which are mixed with bitter purging ſalt, and probably with other ſalts. From all which mixtures it acquires peculiar qualities.

3. FOR from the mixture of clays and earths it acquires *various colours*. The French bay ſalt is commonly grey; where the bottoms of the pits are of blue clay, it is more white; where of a red clay, it hath a reddiſh caſt; and that of Souſton, nigh Bayonne, is of a greeniſh colour. The Portugal and Spaniſh ſalts are whiter and purer than the French, but yet retain a conſiderable mixture of mud and dirt. In general, all ſalt when dry, is more white; when moiſt, more pellucid.

4. SOME kinds of bay ſalt are *more apt to contract a moiſture from the air* than other kinds. And this either becauſe the ſalt is of a ſmaller grain, and comes into contact with the air in a greater number of points; or elſe, becauſe of ſome mixture of calcarious, or alcaline ſalts, which greedily imbibe the aqueous moiſture.

5. SOME kinds of bay ſalt are diſtinguiſhed by their *ſmell*; as the Hampſhire and Portugal bay ſalts, which have a fine violet flavour when ſtored up in large heaps; probably from the oleaginous or ſulphureous particles mixed with ſea water, or imbibed by it in the ponds, and there altered and ſubtilized by fermentation.

6. BAY ſalt, from the variety of ſubſtances mixed with it, differs greatly in *taſte*, as well as in other qualities. Thus, according to Galen, the ſalt of the Lake Aſphaltites, or Dead Sea, is extremely nauſeous and bitter; probably from bitter purging ſalt, and other mixtures[1]. The ſalt made at the ſprings of Peccais in Languedoc hath alſo a bitter taſte[2]. Whereas the ſalt made

[1] As from bituminous ſubſtances, which abound in other ſalt waters, as well as in thoſe of the Dead Sea. The reader may give what credit he thinks fit to the following inſtance from Pliny. "Fit [ſcil. ſal communis] et e puteis in ſalinas ingeſtis. Prima denſatio "Babylone in bitumen liquidum cogitur, oleo ſimile, "quo & in lucernis utuntur: hoc detracto ſubeſt ſal." *Nat. Hiſt.* lib. xxxi. cap. vii.

[2] Comte Marſilli ſays, that this ſalt is made of ſalt-water drawn from deep wells, and gives the following account of it.

"Le goût du ſel, que l'on fabrique à Peccais, eſt ſalé, "amer, & ſi deſagréable, qu'il n'eſt pas poſſible de "s'en ſervir, la premiere année. On a peine de s'y ac-"coutumer la ſeconde; mais on dit, qu'à la troiſiéme "il ſe rend ſupportable; & qu'à la quatrieme ſon amer-"tume eſt fort peu ſenſible; & va toûjours ainſi, en "diminuant à proportion du progrès des années. On "a coûtume dans ces ſalines d'y diſpoſer la recolte de "l'année, en maſſes, auxquelles on donne le nom de "l'an, qu'elles ont été faites. Elles reſtent de la ſorte "abandonnées à l'injure du tems, qui purge le ſel de "cette amertume pendant trois ans tout au moins, avant "que l'on commence à le diſtribuër.

in the Cape de Verd iſlands, Salt Tortuga, and in many other places from the water of ſprings and lakes hath a very agreeable taſte. Although bay ſalt made from the ſame kind of water in different pits, or from other different circumſtances attending its preparation, may differ greatly in taſte as well as in other qualities. Thus the marine bay ſalt, although commonly palateable, may ſometimes acquire a bitter taſte, from calcarious ſalts mixed with it; as may happen after long droughts, when the pits from which it is drawn have not been freed from bittern.

7. BAY ſalt oft-times *alters in taſte, as well as in other qualities, by long keeping.* The ſalt of Peccais for example, which, when firſt made, is ſo nauſeous and bitter as to be unfit for domeſtic uſes; by keeping, acquires a taſte that is more agreeable. For the bitter purging ſalts being very ſoluble in water, eaſily diſſolve by the moiſture of the air, and ſink through the common ſalt in a liquid form, leaving it more pure, and free

" Juſques à la derniere inondation du Rhone, qui fit " fondre dans ce lieu-là une ſi grande quantité de ſel, il " y en avoit toûjours eu de dix années." *Hiſtoire Phyſique de la Mer*, Partie ii. pag. 35, 36.

from its bitter taſte. Theſe calcarious ſalts may alſo be frequently waſhed by rains from amongſt bay ſalt, as it lies in heaps expoſed to the weather. Alcaline ſalts may, after the ſame manner, be diſcharged from amongſt common ſalt; or when long expoſed to the air, may imbibe its volatile acid ſpirit, and with it be converted into a neutral ſalt. And for theſe reaſons, not only bay ſalt, but moſt other kinds of common ſalt, become better and fitter for domeſtic uſes, by being kept a conſiderable time expoſed to the air in a dry place.

CHAP. II.

Of the different qualities of white ſalt.

WHITE ſalt, as well as bay ſalt, is commonly mixed with various impurities, which it receives from the waters from which it is extracted; and from theſe impurities, and the different methods uſed in its preparation, it is found to acquire very different properties.

1. THE *grain* of *white ſalt differs greatly*, according to the manner of its preparation, as hath before been related. The loaves of ſalt, or baſket ſalt, is of the fineſt grain, being

ing rather powder then cryſtals of ſalt. Of the Britiſh ſea ſalt, that made at Lemington, and of the Britiſh fountain ſalt, the ſhivery ſalt, are of the largeſt grain. But the cryſtals of the ſalt which the Dutch make for curing proviſions, are much larger than thoſe of any other kind of boiled ſalt.

2. WHITE ſalt alſo differs greatly in the *hardneſs and firmneſs of its grain*; ſome kinds of it being of a ſoft, looſe, open grain, which readily crumbles between the fingers; whilſt other kinds are of a firm, hard, regular grain, which is not ſo eaſily broken.

3. IT hath before been obſerved, that the *heterogeneous ſubſtances* moſt commonly mixed with bay ſalt, are clay, mud, and dirt; but thoſe from which white ſalt is ſeldom perfectly free, are the calcarious earth called ſcratch, and the ſalts of bittern; it is alſo frequently contaminated with the additions before ſpoken of, and with dirt, aſhes, coal, ſoot, and other impurities: from all which it receives peculiar qualities, as will be more fully explained hereafter.

4. BOILED ſalts differ greatly as they are *more or leſs durable in the open air*. For violent boiling of the brine not only makes the ſalt of a ſmall irregular grain, as was before

fore obſerved, but alſo diſpoſes it more ſtrongly to attract the moiſture of the air, and to run with it *per deliquium*. And the operators ſay of ſuch ſalt, that it is not well cleared from the freſh. Alcaline ſalts, and the other ſalts of bittern, as they greedily imbibe the aqueous moiſture, diſpoſe the common ſalt, wherewith they are mixed, to grow ſoft and relent in the open air, as hath before been obſerved. It is a general obſervation, that the larger the grain of ſalt, (*cæteris paribus*) the more durable it is in the open air. And ſalt made up into loaves will remain drier than ſalt of the ſame kind which hath its grains diſunited.

5. The ſeveral kinds of boiled ſalt alſo *differ in colour*. That which is of the ſmalleſt grain, the pureſt, and drieſt, is commonly the whiteſt. Moſt of the ſalt made in Scotland, is of a dirty grey colour, not being cleared from mud by clarifying the brine.

6. White ſalt hath commonly *no ſmell*; but ſometimes the corrupted blood uſed in clarifying it, or the unctuous ſubſtances added to it give it one which is very diſagreable.

7. The ſeveral kinds of white ſalt are alſo found to *differ* greatly *in taſte*; for ſome kinds have a much more ſharp and pungent

taſte

taſte than others. In general, that which is of a large grain, and made with a gentle heat, hath a ſharp, biting taſte; whilſt that which is made with haſty fires, and of a ſmall grain, taſtes commonly more flat, and ſoft. There are ſome kinds of white ſalt in which a bitter taſte may plainly be diſcovered; as in ſea ſalt boiled with haſty fires, and not drawn from the bittern at a proper time. The cat ſalt, which cryſtalizes in marine bittern, hath alſo a bitter taſte, but is ſharp, and ſtrong. Moreover, ſalt hath ſometimes a very nauſeous taſte from corrupted blood [r], and other impurities mixed with it by ignorant operators.

8. White ſalt often *undergoes conſiderable alterations by keeping*. The alcaline ſalts intermixed with it being converted into neutrals by the aërial acid; or elſe melted out of it together with the bitter and calcarious ſalts by the moiſture of the air. The ſcratch contained in it may alſo germinate with calcarious ſalts. It is found by experience, that ſea-ſalt prepared after the proceſs before

[r] Dr. Plot aſſerts, that the blood uſed in clarifying ſalt gives it an ill colour, as well as a bad ſavour. *Hiſt. of Staffordſhire*, Chap. ii. § 107. This is confirmed by Dr. Raſtel, in his account of the method of preparing ſalt at Droitwich.

related,

related[z], grows dryer for two or three days whilſt it remains in the crebs; during which time the leach brine drains out of it, and the moiſture alſo exhales from it by its heat. For ſome time after it gains in weight; but afterwards grows dry, and, if not often ſtirred, becomes rocky, adhering together in one ſolid maſs.

9. WHITE ſalt is alſo found to *differ* greatly *in ſtrength*. That ſalt may be eſteemed the ſtrongeſt which hath the moſt briſk and pungent muriatic taſte, and which is found the fitteſt for curing fiſh, fleſh, and other proviſions, and will preſerve them longeſt in hot countries; and will keep them ſweet and good when applied in a ſmaller quantity than is neceſſary of other kinds of ſalt. Of the ſalts abovementioned, bay ſalt, and the Dutch refined ſalt, are the ſtrongeſt; the ſhivery ſalt made in Cheſhire is next in ſtrength; and after it, ſome kinds of brine ſalt; although a ſalt equally ſtrong may be made of the Engliſh rock ſalt or ſea water. The Engliſh refined rock, and ſea ſalts are of different degrees of ſtrength, according to the art uſed in preparing them; ſo that ſome kinds of them are good ſtrong ſalt, whilſt

[z] In Part ii. Chap. ii.

others

others are wholly unfit for preferving provifions.

CHAP. III.

Of the ufes of falt as a feafoning to our food.

SALT hath been ufed by mankind as a feafoning to their food, in all ages, and by all nations, except fome of the moft barbarous, who are deftitute of the neceffaries as well as the conveniencies of life. It provokes the appetite, ftrengthens the ftomach, promotes the digeftion and concoction of the aliment, refifts putrefaction, prevents unnatural concretions of the humours, and is moft friendly and agreeable to the human body, entering its compofition as a neceffary ingredient. No wonder therefore that the Laplanders[1], amongft whom the ufe of falt is unknown,

[1] "Bread and falt are unknown to moft of them (the "Laplanders) they ufing for bread, dried fifh beaten to "powder: and for falt, the inner bark of pine trees "prepared after this manner. viz. They unbark the tal-"left of thofe trees, efpecially that part which is next to "the ground, and take of it the inner bark, whofe feveral "coats they part afunder, and expofe them well "cleaned to the fun to dry: then they tear them into "fmall parts, and put them into pretty big boxes, made "of the outer bark of trees. Thefe boxes they dig un-"der ground, and cover them with fand, and fo let them

known, ſeem to diſcover the want of it, by the exility of their bodies, and the weakneſs of their conſtitutions; being much leſs robuſt and ſtrong than other northern nations, who enjoy this excellent gift of God. Moreover its uſes extend to many other animals beſides the human race; black cattle and ſheep take a pleaſure in licking it, and by it are preſerved from many diſeaſes[2]; they alſo thrive to admiration, and quickly grow fat in marſhy grounds that are frequently overflowed by the ſea. And if we deſcend to the vegetable tribe, we ſhall find that ſalt contributes greatly to fructify the earth; and when properly uſed as a manure, affords

" be macerated for a whole by their own heat. Then " they make upon thoſe boxes a great fire of blocks " of trees, by which thoſe inner rinds acquire under " ground, a red colour and a grateful ſweetiſh taſte, " ſerving them for a condiment, and ſupplying the " place of ſalt." *Ph. Tranſ.* N°. 102. p. 35. Extracted from Johannis Shefferi *Lapponia.*

[2] " In Hungaria, Polonia, Ruſſia, Tranſylvania, Boruſſia, necnon Græcia ſalis foſſilis fruſta animantibus " objiciuntur, ut ejus uſus internam corruptionem & " morbos arceat." Fred. Hoffman *De fontib. ſalſis Halenſibus, &c.* cap. vii.

" Quin & pecudes armentaque & jumenta ſale max" ime ſolicitantur ad paſtum, multò largiore lacte, mul" tóque gratiore etiam in caſeo dote. Ergo hercule vita " humanior ſine ſale nequit degere," &c. Plin. *Nat. Hiſt.* Lib. xxxi. cap. vii.

ample

ample nouriſhment to corn and other vegetables; and renders kingdoms rich and fertile where it happens to abound in the ſoil[4].

As ſalt poſſeſſes theſe and many other excellent qualities, it therefore deſervedly obtains a conſtant place at our tables, as a ſeaſoning to our food.

In different countries, different kinds of ſalt are applied to this uſe, as beſt ſuits with the conveniency or inclinations of the inhabitants. Many nations are wholly ſupplied with foſſil ſalt; ſome for table uſe prefer bay ſalt, which indeed hath the advantage in the ſharpneſs of its taſte; but the mud

[4] The Rev. Dr. Shaw obſerves, that the ſoil in Barbary is generally impregnated with common ſalt and nitre, and that the waters of moſt of the rivers and lakes have there a ſalt taſte. And to this grand and inexhauſtible fund of ſalts, he very judiciouſly attributes the great fertility for which that country hath always been remarkable; and ſtill continues to be ſo without any other manuring, but the burning, in ſome few places, of the ſtubble.

On the contrary, where this ſalt too much abounds, it kills all vegetables, and renders the earth unfruitful, as may be obſerved in grounds that have been too long overflowed with ſalt water. Many arguments might be uſed to ſhew that the barrenneſs of ſeveral African and Arabian deſerts, proceeds in a great meaſure, from too great abundance of ſalt.

and

and dirt commonly mixed with it, and more especially with the French bay salt, render it less pleasing to the sight. Several, therefore, who are curious in the choice of table salt, use the French cream of salt, or the blown salt of the isle of May.

OTHERS, who would have a cleaner and whiter salt than the common bay salt, choose the purest and largest lumps of it, and reduce them to powder. Others wash them, and dry them before the fire, or in the sun, before they powder them; and are thus furnished with an excellent salt for the table, which they call powder salt.

BUT in most countries, where boiled salt can easily be had, the preference is given to it for table use. And for this purpose, that is most esteemed which is the cleanest, and driest, and whitest, and of the finest grain. Such is the English basket-salt; although much of it is very weak, and of a flat taste, being boiled with hasty fires. Other kinds of white salt, although commonly mixed with scratch, and alcaline and calcarious salts, yet need not be rejected for table use; since those impurities are taken in such small quantities that they can have very little effect upon the human body; and their effects will

in moſt conſtitutions, be ſalutary rather than noxious.

CHAP. IV.

Of the uſe of ſalt as a condiment or pickle.

BESIDES the uſe of ſalt as a ſeaſoning to our meat, it is alſo deſervedly eſteemed the moſt proper condiment or pickle for moſt kinds of food which it is found neceſſary to preſerve.

IN the choice of ſalt for a ſeaſoning, regard may be had to the palate, or to conveniency; but much greater care is neceſſary in the choice of ſalt deſigned for curing proviſions. For ſeveral kinds of ſalt are wholly improper for that purpoſe; and ſeveral kinds of food require a ſtronger or weaker ſalt, to be uſed in larger or ſmaller quantities, either, firſt, according to the different manner of preſerving them; or ſecondly, according to the different nature and qualities of the ſubſtances preſerved; or thirdly, according to the climate, place, or ſeaſon of the year in which they are cured; or laſtly, according to the uſes to which it is propoſed to apply them.

FOR firſt, thoſe kinds of animal food which are ſalted, and afterwards dried either in the ſun, or by kitchen fires, are often as

well preſerved with a weaker, as with a ſtronger kind of ſalt; and ſometimes even better, very ſtrong ſalt being apt to make them too hard, and too ſalt, and not ſo agreeable and wholeſome. Thus ſome of the beſt kinds of hams are cured with common white ſalt, to which a little ſaltpetre is added[1]; and thus preſerved they are found more ſoft and juicy, and not of ſo fiery a taſte as thoſe preſerved with ſtrong bay ſalt. Dried meats may alſo be more eaſily cured with a weak ſalt, than pickled meats. For the juices of animal ſubſtances being inſpiſſated by the heat uſed in drying, cannot run into thoſe inteſtine motions which are the cauſe of putrefaction. The acid of wood or turf ſmoke, to which thoſe ſubſtances are expoſed, may alſo contribute to preſerve them. In the Weſt Indies they can ſcarce cure beef with pickle; but eaſily preſerve it by cutting it into thin ſlices and dipping them into ſea water, and then drying them quickly in the ſun; to which they give the name of Jerked beef. Several kinds of white fiſh are alſo eaſily cured by drying them in

[1] In Virginia they cure their hams with bay ſalt; and it is there a common practice to rub them with the aſhes of hickery wood, inſtead of ſalt-petre, in order to give them a red colour.

the ſun, either without ſalt, or with only uſing a very little.

2. Some kinds of animal food are cured with much greater eaſe than other kinds; and thoſe require the ſtrongeſt ſalt and the greateſt quantity of it which are cured with the greateſt difficulty. In Virginia, and other parts of North America, they can pickle beef with Leverpoole ſalt, ſo as that it will bear exportation to Barbadoes, and others of the Caribbee iſlands; but cannot rightly cure pork, for exportation to the ſame iſlands, without bay ſalt. Herrings and other kinds of fiſh, which abound in a thin ſubtile oil, are more diſpoſed to putrefaction, and require a ſtronger ſalt to cure them, than cod and other white fiſh, which are leſs juicy and unctuous. The livers of moſt animals, eſpecially of fiſh, are ſo apt to corrupt that they can ſcarce be preſerved with any ſalt. Such parts of animals as are compact and firm are alſo more eaſily preſerved than ſuch as are looſe and porous, which readily admit the air, the grand cauſe of putrefaction. And for this reaſon veal and other fleſh meats corrupt moſt quickly, when their cellular membrane hath been blown up by the butchers, which practice is therefore forbidden.

Beef alſo and other pickled meats are obſerved to taint ſooneſt nigh the large veſſels. And the heads of moſt animals (eſpecially of cod and other fiſhes) being very porous, are with great difficulty cured with ſalt. In curing of animal food, regard ought alſo to be had to the condition it was in, when ſlaughtered; for it can ſcarce be well cured if the animal was heated by driving, or much bruiſed before it was killed.

3. IT is found more difficult to cure animal food in hot climates, or in very hot weather, than in places and ſeaſons wherein the weather is more temperate; and the ſtrongeſt ſalt is required where proviſions are preſerved with the greateſt difficulty. In thoſe countries which lie between the tropicks, they ſeldom preſerve the fleſh of animals except by ſalting and drying it in the manner before related; becauſe when they attempt to pickle it, it commonly putrifies before the ſalt can have a due effect upon it. For the ſame cauſe, in temperate climates, the hot ſeaſon of the year is not eſteemed a proper time for ſalting proviſions, except only ſuch kinds as cannot be had at other ſeaſons. It is therefore neceſſary to uſe the

ſtrongeſt

ſtrongeſt ſalt in curing thoſe fiſh which are taken in ſummer, or early in autumn; altho' a weaker kind of ſalt might ſerve particularly for white fiſh, if caught at a more temperate ſeaſon. The places in which thoſe fiſh are cured often make a ſtronger ſalt neceſſary; for it is much more difficult to cure them on ſhip-board, eſpecially in the hold (where there is a moiſt ſtagnating air[2]) than at land, where there are cool cellars and other proper conveniences. And not only great heat and moiſture, but alſo intenſe cold makes the ſeaſon unfavorable for ſalting proviſions; for in hard froſty weather, the houſewives obſerve that animal food will not take ſalt, it being ſo hardened and its juices ſo congealed by the cold that the ſalt cannot penetrate it, and is not diſſolved by it.

Lastly, proviſions muſt be cured in a different manner, and with different kinds of ſalt, according to the uſes for which they are deſigned. For example, beef, herrings, and many other kinds of fleſh and fiſh may be pickled very well for home conſumption

[2] On the banks of Newfoundland they ſalt vaſt quantities of cod in the holds of ſhips, without putting them into caſks; and theſe they call Mud fiſh.

with any good kind of common white ſalt [3]; and, if carefully ſalted with it only once about the month of October, will keep good and ſweet for the whole year in a cool cellar. But fleſh and fiſh ſo ſalted are not fit for ſea proviſions, and would not endure exportation into very hot climates. Thoſe therefore, who are moſt exact in pickling beef for exportation, after the animals have been carefully ſlaughtered, between Michaelmas and Chriſtmas, take their carcaſſes as ſoon

[3] It hath been much diſputed amongſt the proprietors of the ſeveral kinds of Britiſh ſalt-works, which kind of white ſalt was fitteſt for preſerving proviſions. The proprietors of the Newcaſtle ſalt-works aſſert, that their ſalt is the beſt for this uſe, as being moſt approved of at the Victualling-office. The owners of the Lemmington works affirm, that their ſalt is the ſtrongeſt and of the largeſt grain. Many again aſſure us, that for ſtrength and purity no kind of white ſalt comes up to the brine ſalt, eſpecially to that which is made at Droitwich. It may perhaps be more difficult than many imagine, to determine which of theſe opinions is beſt ſupported by facts, ſince all theſe kinds of ſalt differ greatly according as more or leſs care and ſkill is uſed in their preparation. However, I ſhall preſume to remark, that, in general, the Britiſh white ſalt is weak and impure; and though it may ſerve to cure proviſions after the manner and for the uſes here mentioned; yet, if uſed alone, will ſcarce preſerve them for long voyages into hot countries; and further, that either through the bad management or the ignorance of the operators, ſalt hath often been made as well from brine as ſea water, which hath been found wholly unfit for preſerving proviſions.

as cold, and cut them into proper pieces; and after rubbing each piece carefully with good white ſalt[4], lay them on heaps in a

[4] The method here deſcribed agrees pretty well with that which is practiſed in Ireland in curing beef for naval proviſions, and for exportation into the American colonies. The white ſalt there uſed is chiefly brine ſalt, or refined rock ſalt which they have from Leverpool. Bay ſalt they have chiefly from St. Ubes and other parts of Portugal; many of their ſalters will not uſe French ſalt, (though much cheaper) becauſe of its dirtineſs; and in ſalting commonly uſe about equal quantities of white and bay ſalt.

The white ſalt uſed at the Victualling-office in London, is altogether Newcaſtle marine ſalt; with which they require certificates upon the oath of the vender, that the ſalt ſold to them was made at Shields or other places nigh Newcaſtle, and is, at leaſt, three months old. The method there practiſed of ſalting fleſh for the Britiſh navy, is related in the following manner, by the Rev. Dr. Hales *Philoſ. exper.* pag. 89.

" They firſt rub it with white ſalt only; then put it " into brine for five days to drain the bloody part out, " for it is the blood that is moſt apt to putrify: then " they pack it in caſks, ſtrewing white and bay ſalt be-" tween each laying: then fill the caſk up with pickle " made of water and ſalt, boiled ſo ſtrong as to bear an " egg: they put three pounds and an half of ſalt to a " gallon of water. The proportion of ſalt, pickle in-" cluded, is, to an hundred weight of fleſh, four gallons " and a half of white, and one and a quarter of bay " ſalt."

The ſame gentleman tried how far fleſh might be cured by injecting a ſtrong brine into whole carcaſſes of animals by the Aorta. An ox being thus treated, " two " caſks of the fleſh which was not ſalted with dry ſalt,

cool cellar, in a drab with a ſhelving bottom, where they remain for four or five days, 'till the blood hath drained out of the larger veſſels. They then take the pieces, and dry them with a cloth, and rub them for the ſecond time with powdered bay ſalt. They are then fit to be put up in caſks, and much care is uſed in packing them cloſe, and in ſtrewing between them large lumps of bay ſalt, as they are put up. When the caſks are filled with beef, their heads are fitted in; and all the vacuities are afterwards filled up with the ſtrongeſt brine that can be made, which is poured in by a hole in the head of the caſk. This hole is afterwards cloſed up, and the caſk is made ſo tight, that none of the brine can leak out,

" ſoon ſtunk to a very great degree.—The fleſh of two " other caſks of the ſame ox, which was ſalted with dry " ſalt before it was packed in the cask, being examined " eighteen months after, and a piece of it boiled, it " was judged not fit for men to eat, as its juices were " entirely eat up by the ſalt, and it fell in pieces like rotten wood. The mutton of a ſheep that was hunted immediately before it was killed, being injected in the " ſame manner, and afterwards ſalted with dry ſalt, and " kept full ſix months, proved good and ſweet, and not " too ſalt when firſt freſhened in water." The ſame gentleman is of opinion, that this method might be of great uſe in hot climates, where fleſh cannot be preſerved by the common methods.

and

and no air can gain admittance. It is found by experience, that beef cured in this manner will keep good and ſweet for years in the hotteſt climates.

THE Dutch, as hath before been obſerved, uſe no ſalt for curing proviſions, beſides their own refined ſalt. With it they can preſerve fleſh and fiſh of all kinds as well as with the ſtrongeſt bay ſalt; and chuſe to be at the expence of refining bay ſalt, rather than to defile their proviſions with the dirt and other impurities, with which it commonly abounds.

FROM the foregoing accounts it appears, that various kinds of ſalt are uſed for curing proviſions; but the ſalt which may in general be eſteemed the beſt for that purpoſe, as preſerving animal food moſt effectually, and for the longeſt time, is that which is the *ſtrongeſt* and *pureſt*; and may be known by the following characters, viz.

IT is uſually concreted into large grains or cryſtals, which are firm and hard, and in reſpect to thoſe of other kinds of common ſalt, the moſt ſolid and ponderous; it is not diſpoſed to grow ſoft or moiſt in a moderately dry air, to which it muſt have been expoſed a conſiderable time; its colour is white,

white, and somewhat diaphanous; it hath no smell; its taste is truly muriatic, and more sharp and pungent than that of other kinds of common salt; being dissolved in pure water it casts up no scum, and deposits no sediment; being mixed with syrup of violets diluted in water, it heightens its blue colour, and does not turn it either green or red; and, by the exactest chemical trials, discovers no scratch, no alcaline, bitter, or calcarious salts, nor any other impurities whatsoever intermixed with it.

THE salts which approach nighest to this degree of perfection are the best kinds of bay salt, and the strong Dutch refined salt; but most of the salt now made for sale is very far from answering to these characteristics, as will more fully appear in the following parts of this performance.

THE ART of making BAY SALT.

PART III.

In which, ſeveral methods are propoſed for making bay ſalt in England, and other parts of the Britiſh dominions.

IN the foregoing parts of this work, I have briefly related the various methods of preparing ſalt that now are in uſe, ſo far as they are come to my knowledge; and alſo treated of the qualities and uſes of the ſeveral kinds of common ſalt as a condiment, and ſeaſoning to our food. From which ſhort narrative it appears, that the art of preparing ſalt is not brought to ſuch perfection in the Britiſh dominions, as in ſeveral other countries, the ſalt there prepared being unfit for preſerving many kinds of proviſions. It remains now to ſhew, that this want of ſtrong ſalt of Britiſh manufacture, proceeds not from any defect of na-

ture, but of art; and that if proper ſkill and induſtry be uſed in the Britiſh dominions, and due encouragements be there given by the legiſlature, ſuch improvements may be made in this art, that not only Great Britain, but Ireland alſo, and the Britiſh colonies in America, may be ſupplied with ſalt of their own manufacture, proper for curing all kinds of proviſions, in quantity ſufficient for all their occaſions, in quality equal, if not ſuperior, to any foreign ſalt now made, and at a moderate price. Theſe are truths which I hope will appear evident from the facts and reaſonings contained under the following propoſitions.

LEMMA I.

The quantity of water which annually falls in rain, ſnow, and hail, is very different in different parts of Great Britain; there commonly falling almoſt double the quantity on the weſtern coaſts, that falls on the eaſtern coaſts of that iſland.

According to the obſervations hitherto made, the depth of water which annually falls on the ground, ſuppoſing it all to ſtagnate thereon, would, at a medium, amount at

at Townly in Lancaſhire to forty-two inches and a half[1]: at Plymouth to thirty-one inches[2]: at Upminſter in Eſſex to nineteen inches and a quarter[3]: at Widrington in Northumberland to twenty-one inches and a quarter[4]: at Edinburgh to twenty-two inches and a half[5].

THIS great difference in the quantity of water which falls in different parts of this iſland is not (as the Rev. Mr. Derham[6] and others ſuppoſe) owing chiefly to the plainneſs or hillineſs of the different parts of the country, but to ſeveral other concurrent cauſes, and more eſpecially to the different qualities of winds in different places, and to the ſituation which thoſe ſeveral places have, with reſpect to ſeas, or tracts of dry-land.

THE winds, which blow moſt frequently in Great Britain, are the ſouth, ſouth-weſt,

[1] See Mr. Townley's *Obſ.* in the *Acts of the Royal Society.*

[2] See Dr. Huxham in his treatiſe *De aere & morb. epidem. Plym.* and *Medical Eſſays*, vol. v. art. iii.

[3] See Mr. Derham's *Meteorolog. Obſ.* in the *Ph. Tranſ.*

[4] *Ph. Tranſ.* Gray's *Ab.* vol. ii. pag. 45.

[5] *Medical Eſſays*, vol. v. art. iii.

[6] See his *Phyſico-Theol.* Book iii. chap. v. note L. Alſo *Ph. Tr.* N° 286 and 297.

and

and weſt winds. Theſe are alſo the warmeſt winds, raiſing vaſt quantities of clouds and vapours, which they drive before them from the great weſtern ocean and Iriſh ſea. The greateſt part of theſe clouds and vapours falls upon the coaſts from Land's-end to the north of Scotland. And hence Wales, Lancaſhire, Cumberland, and other places ſituated on the weſtern coaſt, are watered with heavier ſhowers than any other parts of the iſland. For (as Mr. Townly[7] formerly obſerved) the clouds and vapours driven from the ſea ſeldom paſs to the oppoſite ſides of the iſle, but generally deſcend in rains and other watery meteors, before they have paſſed thoſe ridges of mountains which run along the middle of it. So that the ſouth and ſouth-weſt winds are rainy winds in Lancaſhire, and all other places on the weſtern coaſts, but dry winds on the eaſtern coaſts: whereas, on the contrary, the eaſterly winds bring rain and ſnow with them to the eaſtern coaſts, but are dry parching winds on the weſtern coaſts of the iſle. And this rule takes place even in the narroweſt parts of Great Britain, as in the counties of Lancaſhire, and Cumberland on one ſide,

[7] *Ph. Tranſ.* N° 208. pag. 53.

and

and Northumberland, Durham, and York-ſhire on the other, where the land winds are the dryeſt winds, and the ſea winds the moſt wet and moiſt; which alſo holds true in moſt other parts of the world.

Now as the eaſterly winds blow more ſeldom in Great Britain, than the ſouth and ſouth-weſt winds, and are alſo colder, and bring leſs moiſture along with them; therefore the quantity of rain falling on the eaſt coaſts is only about half as much as falls upon the weſt coaſts of the iſland, and the quantity of rain which falls in Kent, Eſſex, Middleſex, Suffolk, and Norfolk, is probably leſs than in any other parts of the kingdom. For theſe counties are the fartheſt diſtant from the weſtern ocean; and the eaſterly winds are not in them very rainy, as they only blow over a ſmall tract of the German ocean. As to Plymouth, and the ſouth coaſt from the Land's-end to Dover, the ſouth and ſouth-weſt winds[8] bring thither the largeſt quantity of vapours and rain; and for reaſons very obvious, the quantity of water which falls there, is leſs than on the weſt coaſts, and greater than on the eaſt coaſts of the kingdom.

[8] *Medical Eſſays*, vol. v. art. iii.

LEM-

LEMMA II.

The quantity of rain which falls in Lancashire, during the four hotteſt months of the year, viz. May, June, July, and Auguſt, doth not at a medium amount to more than a third part of the quantity of water, which falls in rain, ſnows, and hail, during the whole year.

HAVING purpoſely made the calculation from Mr. Townly's obſervations[1]; I find that the quantity of water which fell in Lancaſhire for fifteen years ſucceſſively, in the months of May, June, July, and Auguſt, was to the quantity falling in the other eight months of the year during that time, in proportion as 20525 : 41595. So that during thoſe fifteen years there fell above twice the quantity of water in rain, ſnow, and hail, in the eight colder months than there fell in the four hotteſt months of thoſe years. The ſame will probably hold true in other parts of the kingdom[2].

[1] See *Ph. Tranſ.* N° 208, or Lowthorp's *Ab.* vol. ii. pag. 44.

[2] At Padua the rain which fell for ſix years in the ſummer quarters, was to the rain which fell in the other

LEM-

LEMMA III.

The water, which aſcends in vapours from the ſea, very greatly exceeds that which deſcends thereon in rain and other aqueous meteors: But the quantity of water, which uſually exhales from a given part of the ocean in a given time, cannot with any exactneſs be determined[1].

FROM the foregoing obſervations it appears, that the exhalations which ſupply this iſland with rain, are brought chiefly from the ſea, the winds which blow over land being generally dry winds, and the ſea winds commonly bringing rain and vapours.

three quarters of thoſe years as 5825 to 168.828. So that, during thoſe ſix years, there fell in the ſummer quarters ſomewhat more than a quarter part of the rain which fell there in all thoſe years. For 5.825 : 17.475 : : 1 : 3. See *Ph. Tr.* N° 421.

[1] The firſt part of this propoſition holds true of the ſea in general; though it might prove falſe, if applied to particular parts of it. For as at dry land, ſo alſo at ſea, there are ſome places where it rains almoſt conſtantly, and others where it rains ſeldom or never. For example; in that part of the Atlantic ocean called the Rains, and in the Andes of Peru, it rains almoſt continually; whereas in Egypt, and in the plain country along the coaſts of Peru, and in ſeveral parts of the Pacific ocean it rains very ſeldom; and in ſome of theſe places ſcarce ever.

Which rule, if extended to other countries, is found more generally true on large continents than in iſlands. The evaporations therefore ariſing from the ſea muſt very much exceed the aqueous meteors which fall upon its ſurface (as Dr. Halley and others have demonſtrated;) for otherwiſe there would not be a ſufficient quantity of vapours raiſed from the ſea, not only to ſupply it, but the dry land alſo, with rain and other watery meteors.

But the experiments made by Dr. Halley and others, with a view to determine the exact quantity of vapours ariſing from the ſea, are very inſufficient for that purpoſe, being only calculated to ſhew the great power of the ſun's heat in raiſing exhalations; although this power does not extend to any great depth of the ocean, but is exerted chiefly on the ſuperficial waters, and, in theſe northern climates, only at certain ſeaſons of the year.

But there is another heat, whoſe power hath been little conſidered, by means of which vaſt quantities of vapours are continually raiſed, in winter, as well as in ſummer, by night as well as by day, from the profoundeſt parts of the ocean. And without

out due regard had to the effects of this heat, it will not be eaſy to account for thoſe vapours, which fall in rain and ſnow in the coldeſt months of the year. Beſides the ſun's heat, the ſubterraneous heat therefore very greatly promotes the exhalation of watery vapours, eſpecially from the deeper parts of the ocean, where this heat is very conſiderable.

FOR all obſerving ſailors agree, that on the main ocean, and particularly on the great weſtern ocean, the air is always mild and temperate, and the ſurface of the water feels conſtantly warm in the coldeſt ſeaſons of the year; ſo that the ſailors are able to judge of their approach to land by obſerving the water to grow colder[2]. And this great warmth of the ocean at its ſurface, which tempers the winter's cold, doubtleſs proceeds from hot ſteams and vapours, which find a quick and free aſcent from the profounder parts of the ſea. For in thoſe parts of it which are ſhallow, as on the banks of

[2] To the greater cold of the land than of the main ocean in theſe northern climates in winter, may be attributed thoſe colds and catarrhous fevers, which conſtantly affect ſailors after having paſſed the weſtern ocean, as ſoon as they arrive at land either in Great Britain or in North America during the winter ſeaſon.

Newfoundland, the air is found colder, for want of thoſe warm ſteams and vapours, which cannot ſo eaſily and quickly aſcend through the ſolid earth, as through water. And hence thoſe banks are conſtantly covered with thick foggs; the warm vapours which are brought from the deeper parts of the ocean being continually condenſed by the colder air upon thoſe ſhallow parts; in the ſame manner that the watery vapours are continually condenſed into miſts and foggs upon the icy mountains of Greenland during the ſummer ſeaſon[3]. The ſame coutry alſo

[3] "The temperament of the air is not unhealthful; "for, if you except the ſcurvy and diſtempers of the "breaſt, they know nothing here of the many other diſ-"eaſes, with which other countries are plagued; and "theſe pectoral infirmities are not ſo much the effects of "the exceſſive cold, as of the naſty foggiſh weather, which "this country is very much ſubject to; which I "impute to the vaſt quantities of ice that covers the "land, and drives in the ſea. From the beginning of "April to the end of July is the foggiſh ſeaſon, and "from that time the fogg daily decreaſes. But as in "the ſummer time they are troubled with the fogg, ſo "in the winter ſeaſon they are likewiſe plagued with the "vapour called froſt-ſmoke; which when the cold is "exceſſive, riſes out of the ſea, as the ſmoke out of a "chimney, and is as thick as the thickeſt miſt, eſpe-"cially in the bays where there is an opening in the "ice. It is very remarkable that this froſt, damp, or "ſmoke, if you come near it, will ſinge the very ſkin

 furniſhes

furnisheth us with a notable instance of the great power of the subterraneal heat in raising vapours even in the coldest seasons of the year. For on the coasts of Greenland, when the surface of the sea is all frozen into ice, if there chances to be an opening therein, the warm vapours, which before were pent up beneath it, arise so copiously, that being suddenly condensed by the cold they appear like smoke arising out of a chimney. This inward heat of the sea hath therefore no dependance upon the sun's heat, but is equal in winter and summer; or even greater in winter, especially where the surface of the sea is then covered with ice; and is so considerable, that in the coldest seasons of the year it continually agitates the aqueous particles, separates them from each other, and converts them into an elastic fluid. In this manner vast quantities of watery vapours are continually raised from the profoundest

"of your face, and hands; but when you are in it "you find no such piercing or singeing sharpness, but "warm and soft, only it leaves a white frost upon "your hair and cloaths." Mr. Egede, *Nat. Hist. of Greenland.*

N. B. The skin is probably singed, as observed by the author, by first being relaxed by the warm watery vapour, and then immediately frozen by the cold.

parts of the ocean. So that in eſtimating the evaporations from the ſea, regard ſhould be had to its inward heat, to its depth, and to the bulk of water which it contains, as well as to its ſurface and the cauſes which act thereon.

As to the ſubterraneous heat hath therefore a very remarkable effect in raiſing vapours from the ſea, it may, together with the force of the air and winds, be eſteemed ſufficient to elevate the greateſt part of thoſe vapours, which in this climate fall in watery meteors during the winter ſeaſon. That the air and winds lick up vaſt quantities of vapours hath long been obſerved, but this their effect may probably be hereafter more fully explained by electrical experiments[4]. It is however certain, that the particles of dry compreſſed air very ſtrongly attract the aqueous particles, and continually unite with them at the ſurface of the water, and from thence are continually driven away with them by the force of the winds. The winds alſo conſiderably promote this operation of the air by agitating the water into waves, and encreaſing its ſurface (often to double what it is when ſuffered to ſubſide into

[4] See Dr. Deſagulier's *Treatiſe on Electricity.*

a plain)

a plain) thus making the contact between the air and water more vigorous and brisk, and in a much greater number of points. And from these reasons, and such experiments as have been made, the best judges have concluded, that at least as much water is exhaled by the air and winds, as by the sun even in the hottest seasons of the year[5].

Now the ascent of vapours is retarded by the absence of the heat of the sun, and of the subterraneal heat, also by a moist and light air saturated with vapours, not agitated by winds, but hanging without motion over the surface of the water; by rain filling the

[5] As Dr. Halley and Dr. Borehaave. From the latter of whom the following passage is extracted. "Tandem, "non est alia causa, quæ tantam copiam aquæ de "terra in aërem evehit, quam ventus; quod idem "eximius Halleius pulchre docuit, quod variis experi-"mentis ad stuporem usque didici. Dum enim cylin-"drum cupreum aqua plenum tempestati procellosæ "exponebam, mirabar quam incredibilis aquæ copia "parvo tempore difflaretur: quum statim postquam "ventus silebat, parum modo in eodem cœli calore "exhalaret." *Chemiæ Part. Alt. cap. De aëre.*

"The surface of water is liked up somewhat faster by "winds than it exhales by the heat of the sun, as is "well know to those who have considered those dry-"ing winds which blow sometimes." Dr. Halley in *Ph. Tr. abr. by* Lowthorp, vol. ii. p. 110.

air with moiſture, and beating down the aqueous particles in their aſcent from the earth; by froſts congealing the ſurface of the waters and by other cauſes on which it would be tedious here to inſiſt.

As therefore the cauſes which promote or retard the aſcent of marine vapours are very numerous, and ſeveral of them ſubject to continual variations, and the true effect of others can ſcarce be determined, as of the ſubterraneal heat; neither can the quantity of water on which it acts be diſcovered; for theſe reaſons, it ſeems impoſſible to eſtimate with any exactneſs the quantity of vapours which uſually ariſe from a certain portion of the ſea in a certain time. The experiments hitherto made for that purpoſe were generally made upon water ſet in cloſe rooms, or at leaſt in ſhady places, where the rain could give no interruption; but where alſo neither the ſun nor air could have their due effects upon it, and where it could not, as in the deeper parts of the ocean, be much affected by ſubterraneous heat. The calculations therefore made from ſuch experiments muſt needs be extremely inaccurate; ſo that little certain can be determined from them concerning the evaporations made from the ſea, although they

they may be of uſe in demonſtrating the following propoſition which more nearly relates to our preſent purpuſe.

LEMMA IV.

The quantity of water which commonly exhales in Great Britain from ſhallow ponds during the four hotteſt months of the year, greatly exceeds the quantity of rain which commonly falls on the ſurface of thoſe ponds during the ſaid months.

THE ponds of the French ſalt marſhes may well be eſteemed ſhallow ponds, ſuch as here ſuppoſed; and ſo may all others, which do not exceed the depth of two feet. In ſuch ponds the water is not much acted upon by ſubterraneal heat; and therefore it is only neceſſary here to conſider the effects of the ſun and air upon water contained in them during the four hotteſt months of the year. And theſe effects will be much the ſame, whether the water be expoſed to the ſun and air in ſhallow veſſels or in ſuch ponds as are here ſuppoſed.

THE accurate Kruquius obſerved, that at Delft in Holland the quantity of water falling

ling on the ſurface of the ground did, one year with another, amount to about thirty inches; and that about the ſame quantity exhaled again from water placed there in the open air, but in a calm and ſhady place. And it is not to be doubted but that double the quantity, or ſixty inches depth of water, would have annually exhaled, had it been placed where the ſun and winds could have had their due effects upon it.

[1] Dr. Halley found by exact experiments made at London, that water placed there in a cloſe room, where neither the winds nor ſun could act upon it, exhaled only the depth of eight inches during the whole year. He obſerves, that "when once the ſurface "of the water is inveſted with a fleece of "vapours, the vapour riſes afterwards in "much leſs quantity. And that when the "air was ſtill from wind, much leſs was "evaporated than when there blew a ſtrong "gale, although the experiment was made "in a cloſe room." And makes no doubt, "that, had the experiment been made where "the wind had come freely, it would have "carried away three times as much water

[1] See his *Exp.* in the *Ph. Tr.* N°. 212. or *Lowthorp abr.* vol. ii. p. 3.

"without

"without the aſſiſtance of the ſun, which "would perhaps have doubled it."

So that, according to his calculations, about the depth of forty eight inches exhales at London, in the open air, from the ſurface of water during the whole year.

FROM the ſame experiments it appears, that the evaporations in May, June, July, and Auguſt, which are nearly equal, are about three times as great as in the months of November, December, January, and February, which are likewiſe nearly equal. And having purpoſely ſummed up the evaporations, which he has ſet down as made in the four months of May, June, July, and Auguſt, I find them to the evaporations of the other eight months of year in the proportion of 85575 to 77345. So that the evaporations made in the four hotteſt months of the year, were more by a tenth part than thoſe of all the other eight months.

SUPPOSING therefore that equal quantities of vapours exhale from ſhallow ponds in the four hotteſt months, and in the eight colder months of the year; and that a third part of the water, which annually falls in rain and other aqueous meteors, falls in the four hotteſt months: Then if, according to

to Kruquius's obſervations in Holland, ſixty inches of water exhales during the year in vapours, and thirty inches again fall in rain, thirty inches will exhale in the four hotteſt months, and only ten inches will fall; ſo that an exceſs of twenty inches of water will ariſe, more than will fall during thoſe four months[2].

If again we make uſe of Dr. Halley's eſtimate, and ſuppoſe that forty eight inches of water annually ariſe in exhalations from the ſurface of ponds at London; and if (agreeable to obſervations) we allow twenty one inches of water to fall there in meteors during the whole year; then ſeventeen inches of water will there exhale from the ſurface of ponds more than is received into them in rains during the four hotteſt months[3]. But in the moſt rainy parts of England, where $\frac{42}{3}$ or fourteen inches of water may be ſuppoſed to fall during the four months above mentioned, then, if in that time twenty four inches of water ſhould be found to exhale, only 24—14=or ten inches of water will in ſuch parts exhale from ponds, more than deſcends during the ſaid four months[3].

[2] For $\frac{60}{2} - \frac{30}{3} = 30 - 10 = 20$.

[3] For $\frac{48}{2} - \frac{21}{3} = 24 - 7 = 17$.

But

BUT all theſe calculations of the evaporations from ponds during the four hotteſt months are probably ſhort of the true quantity. For it has been obſerved in France, that in exceeding hot weather water expoſed there to the ſun and air, will loſe an inch of its depth in twenty four hours. And from experiments made by Dr. Halley it appears, that ſea water of the ſame temperature with the air in the hotteſt weather in England, placed in a cloſe room, loſt a fifth part of an inch in twenty four hours; and no doubt, if agitated by the wind, would have loſt at leaſt triple that quantity, or three fifths of an inch, in the ſame ſpace of time; and ſhould the ſaid evaporation continue conſtant during the four ſummer months, it would in that time amount to $73\frac{4}{5}$ inches, which is more than thrice the quantity allowed in the above calculations.

PROP. I.

In ſeveral parts of England large quantities of bay ſalt may be extracted from ſea water during the hotteſt months of the year; by receiving the ſalt-water into ponds, and ſuffering its aqueous parts thence to exhale

by

by the heat of the sun, and the operation of the air and winds.

For if in some of the warmest and least rainy parts of England a pond, at a moderate computation, usually loses seventeen inches depth of water in exhalations during the four hottest months, more than it receives from the heavens during the same time; then if a firm and tight pond be filled with sea water to the depth of sixteen inches in the beginning of May, all that water, together with the rains that fall into the pond, will be usually thence exhaled by the end of August, and the bottom of the pond will remain covered with a crust of salt; as in summer may be observed on the sea shore in hollows of rocks, where small quantities of sea water have been left by the tide, or, as is more observable in the salinæ before described[1], from which vast quantities of salt are annually collected.

The evaporation of sixteen inches depth of water by the sun and air, is here supposed to take up four months: in rainy summers it may require a longer time, or even may not be effected during the whole

[1] Part ii. Chap. ii.

summer,

ſummer. But it alſo often happens in many parts of England, that not an inch depth of water falls in a whole ſummer month, and the weather in ſuch dry ſeaſons being uſually very hot, half an inch depth of water may then be ſuppoſed to evaporate every day; ſo that the whole evaporation of ſixteen inches depth of ſea water will, in ſuch a dry ſeaſon, be performed in thirty-two days.

THE following calculation may give ſome idea of the quantity of ſalt, which may thus be extracted from ponds covered with ſea water to the depth of ſixteen inches. A cubic inch of pure water weighs about 256 grains; and if we ſuppoſe that the ſea water on the coaſts of England contains $\frac{1}{32}$ part of ſalt, then each cubic inch of ſea water will contain $\frac{256}{32} = 8$ grains of ſalt; and ſixteen cubic inches $16 \times 8 = 128$ grains. There would therefore remain after the evaporation of ſixteen inches depth of water 128 grains of ſalt upon every inch ſquare of the pond, and upon every yard ſquare 21 lb. 9 oz. 288 pwts. averdupoize weight; and upon every ſtatute acre of ſuch ponds 104544 lb. or 1245 buſh. 64 lb. of bay ſalt [2]. The price

[2] Bay ſalt now coſts at London, excluſive of exciſe, four ſhillings and four pence per buſhel.

of

of which, if ſold for a ſhilling a buſhel, would be 62l. 5s. 9d. ſo that ground rightly prepared might thus be made to produce annually an excellent rich crop of ſalt, which would not require more labour and expence than is neceſſary for crops of far leſs value.

But as the above method of preparing bay ſalt from ſea water, is tedious and ſubject to miſcarry by rains, and the ſalt ſo made could ſcarce be collected without mud[3], and the calcarious earth, and other groſs ingredients of ſea water would remain mixed

[3] Mr. Boyle found the ſpecific gravity of a hard lump of ſea ſalt to that of common water almoſt as 2 : 1. But the ſpecific weight of an hard lump of ſal gem. is to that of water nearly as $\frac{1}{2^3}$: 1. If therefore (as before ſuppoſed) each ſquare inch of the bottom of the pond was covered with a cruſt of ſalt weighing 128 grains then the ſaid cruſt would only be a quarter of an inch in thickneſs. For 250, the number of grains in a cubic inch of water, being divided by 2, gives 128. So that if a cubic inch of water be divided into two equal parts by a plain parallel to its baſe, each of thoſe parts will weigh 128. and the altitude of each will be half an inch. But the altitude or thickneſs of a cruſt of ſalt upon the ſame baſe, and alſo weighing 128. will only be $\frac{1}{4}$ of an inch; ſeeing that the ſpecific weight of ſalt is double to that of common water. But ſo thin a cruſt of ſalt could ſcarce be ſeparated from the bottom of the pond, without a large proportion of mud and other impurities adhering to it.

with

with it, it would not therefore be adviſeable to make a trial of this method; eſpecially as the following may eaſily be put in practice, which is far more commodious, expeditious, and certain.

PROP. II.

In ſeveral parts of England large quantities of bay ſalt may very commodiouſly be extracted from ſea water, after the ſame manner that is practiſed in France, and in other parts of Europe.

THE parts of England moſt proper for this work are thoſe which are the warmeſt and leaſt rainy, as on the coaſts from Dover to Yarmouth: although the ſame work will ſucceed very well in other places [1]. For if ſuch large quantities of bay ſalt can be prepared in France as are ſufficient for the whole annual conſumption of that large kingdom, and of all thoſe nations who purchaſe it from thence, and that in ſo ſhort a time as one fortnight of good weather; why may not large quantities be prepared in the abovementioned, and ſeveral other parts of England, during the whole ſummer ſeaſon? If

[1] Particularly on the coaſt from Dover to Land's-end.

salt can be extracted in France, even in the night time, why may it not in England during the day? If bay salt can be made in considerable quantities, and to profit, in the sun pans of Hampshire[2], why not in larger quantities, and to much greater profit, in salt marshes, which are much more artful and commodious?

There are several parts of the English coast, which do not lie above two or three degrees farther north than the coasts of Britany, where such vast quantities of bay salt are made; and particularly the coasts above pointed out, where this salt is chiefly wanted for curing fish and naval provisions; where the heat of the sun is not much less than on the coasts of Britany; where the winds and air will also have the same effect as in Britany; and where, in all probability, there is considerably less rain to retard the operation, than on the French coasts. So that it is not likely that this work would proceed much slower in England than in France.

But, that this may more plainly appear, let it be granted, that the heat of the sun is so much greater in Britany than on the coasts

[2] See the foregoing accounts of the method of making bay salt in France and Hampshire.

of

of Effex and Suffolk, that water will exhale even twice as faft in the firft, as it does in the laft mentioned places, during the fummer months. Allowing even this fuppofition, it will be no difficult matter to fhew, that fuch an inconveniency might be overcome; and that, under fuch circumftances, as much falt might be prepared in an Englifh falt marfh as in one in Britany, and with no great difference of expence.

SUPPOSING therefore, that from a furface of one yard fquare, as much water exhales in Britany, as from a furface of two fquare yards in England. And if we farther fuppofe two cylindrical veffels of equal capacities, but fo formed, that the furface of the fluid in one, is double to the furface of the fluid in the other, and that thefe veffels, when filled with water, are placed, that with the larger furface, in England, and that with the fmaller furface, in Britany: then, according to the firft fuppofition, equal quantities of water will exhale from thofe two veffels in equal times, and both veffels, as they contain the fame quantity of water, will become empty in the fame fpace of time. And if the water in both veffels be of an equal faltnefs, an equal quantity of

 falt

ſalt will remain in each veſſel, after all the water is exhaled.

It is therefore very poſſible to anſwer all the requiſites in the following problem, viz. *By a moderate heat of the ſun, and the force of the air, from a given quantity of water to exhale a certain quantity given, in a given time*; for this may be done by proportioning the ſurface of the water to the force of the ſun and air, and to the quantity of water required to be exhaled in the time given.

Should it then be required to make the ſame quantity of bay ſalt at a ſalt work in England, as is uſually made at a ſalt work of the ſame kind on the coaſt of France; that this may be done, it is neceſſary that equal quantities of ſea water (ſuppoſed at both places of an equal ſaltneſs) ſhould be received into both works, and that the evaporation ſhould be equal in both. Which would be the caſe, if the water in the ſalt work in England be expoſed to the ſun and air with a greater ſurface than in the French work; ſo that this greater extent of ſurface may compenſate for the leſs force of the ſun's heat: or, in other words, ſo that the whole ſurface of the two ſalt works may be in a reciprocal

reciprocal proportion with the evaporations from equal portions of their ſurfaces. For example; if the evaporation from a certain part of the French ſalt work, be double to the evaporation from an equal part of the Engliſh work, then muſt the ſurface of the Engliſh work be double the ſurface of the French work. And ſince an equal quantity of ſalt water or brine is ſuppoſed to be contained in both works, therefore the Engliſh pits muſt in ſuch caſe have only half the depth of water in them, that is in the French pits. So that in the reſervoir, where there is ten inches depth of water in the French work, there muſt be only five inches depth in the Engliſh work, and in the ſhallower pits in the ſame proportion.

THE foregoing calculations are made upon a ſuppoſition, that it is dry weather, during the whole time that the water is evaporating; but as in the ſalt marſhes this buſineſs is frequently diſturbed by rains, it is neceſſary, in practice, alſo to make an allowance for the water received from the atmoſphere into the ſalt marſh during the evaporation; and upon that account, to enlarge the ſurface of the Engliſh work yet conſiderably farther. For ſuppoſing only

the ſame quantity of rain to fall into the Engliſh, as into the French ſalt work, as the evaporation is ſuppoſed ſlower upon a certain part of the Engliſh work than upon an equal part of the French work, it is neceſſary, that the water falling into the firſt work be ſpread over a larger ſurface, than that which falls into the latter, in order that in both it may be exhaled in equal times. But as the ſurface of the Engliſh work is ſuppoſed larger than the ſurface of the French work, more rain may probably fall into it than into the French work; ſo that it may be neceſſary to extend the ſurface ſtill farther; and ſo to evaporate the exceſs of water, which it receives from the atmoſphere.

How far it may be really neceſſary to extend the Engliſh work farther than a French work of the ſame capacity, in order to make an equal quantity of ſalt in each of them, can only be aſcertained by proper experiments. But all circumſtances being duly conſidered, we may reaſonably conjecture, that, in ſeveral parts of England, if a ſalt marſh was formed, whoſe ſurface was only a fifth or a ſixth part larger than that of a French ſalt marſh, as much ſalt, at leaſt, might be prepared in the Engliſh marſh, as

in

in that of France. And if we consider the situation of the French coast, how it must be watered with heavy rains from the western ocean, we cannot suppose that less water falls there in rain and other aqueous meteors, than on the coast about Plymouth, which at a medium is thirty-one inches in the year; whereas on several of the warmest parts of the English coasts there does not annually fall above twenty inches. So that during the summer season more water will probably fall into the French salt marsh than into one of a fifth part larger surface, situated on the coasts of Essex, Norfolk, or Suffolk.

IF therefore it should prove true in fact, as in all probability it will, that as much salt may be extracted from an English salt marsh, as from one in France, when the surface of the former is one fifth larger than that of the latter: then, in order that both works may contain an equal quantity of brine[3], it will be necessary, that in the re-

[3] The following theorem may be of use in determining the depths of the several ponds, so that the two salt marshes may be made to contain equal quantities of brine, viz.
As the surface of the broader pond in the English marsh, is to the depth of the narrower pond in the French marsh;

ſervoir where the ſalt water is ten inches deep in France, it be eight inches one third in England; and the ſalt pits where the brine is one inch and an half deep in France, it muſt be one inch and a quarter deep in England[4]. And care ſhould be taken to lay the bottoms of the ſeveral pits in ſuch a manner, that the depth of the brine in them may anſwer to the above-mentioned proportions.

THE Engliſh ſalt marſh muſt be made larger or ſmaller as occaſion requires; ſo that care be taken to obſerve the above, or

ſo reciprocally the ſurface of the narrower, is to the depth of the broader.

Thus, if the ſurface of the French reſervoir be a hundred yards ſquare, it's ſurface will then contain 5760000 ſquare inches. And the Engliſh reſervoir $5760000 \times \frac{5760000}{5} = 6912000$ ſquare inches. Then as the French reſervoir is ten inches deep, according to the above theorem, $6912000 : 10 :: 5760000 : 8\frac{1}{3}$. And the product of the two extremes will be found equal to that of the two means, which give the ſolid contents of the French reſervoir in cubic inches.

[4] Suppoſing the French ſalt pits ten inches ſquare, their ſurface will contain a hundred ſquare inches; and the ſurface of the Engliſh ſalt pits (being one fifth of an inch larger) 120 ſquare inches: then, $120 : 1\frac{1}{2} :: 100 : 1\frac{3}{12} = 1\frac{1}{4}$.

The ſame proportion will hold good, if the ſurface of the French ſalt pits be ſuppoſed of any other magnitude.

ſuch

ſuch other proportion in the dimenſions of its ſeveral parts, as by experience ſhall be found moſt proper. In general, it is neceſſary that the reſervoir and brine ponds be of a ſufficient magnitude to furniſh the ſalt pits with a conſtant ſupply of the ſtrongeſt brine, in the place of that which is continually reduced to ſalt.

PROP. III.

Bay ſalt may be extracted in England from ſea water in larger quantities, and with more certainty, than by the foregoing method, if care be taken to preſerve the brine contained in the ſalt pits from being diluted with rains, and to promote the evaporation of the water by ſeveral artificial means, which may eaſily be put in practice.

THE above related method is eaſy and practicable; and we find one much leſs commodious ſucceed to advantage on the coaſts of Hampſhire, where there falls one third more rain than in ſeveral other parts of the Engliſh coaſt. But thoſe who are deſirous of preparing more ſalt than can be done by the foregoing methods, and would have their work leſs interrupted by rains,

and

and would chuſe to have their brine lie deeper in the ſalt pits, and to have the ſalt formed into large cryſtals, may for theſe and other purpoſes have recourſe to the following methods.

First, it will be proper to make all the ſalts pits of the marſh, in one long row, extended from eaſt to weſt[1], and for each pit to make covers of thin boards, or rather of coarſe canvas, or ſail-cloth, ſtretched on frames of wood, and painted white. Theſe covers muſt all be fixed with hinges to ſtrong poſts and beams on the north ſide of the pits, ſo that they may be let down and drawn up with cords and pulleys, or by ſome other contrivance, ſomewhat like draw-bridges. Theſe covers thus fixed may be let down over the pits like a ſhed or pent-houſe, in rainy weather; and in dry weather may be erected almoſt to a perpendicular, but inclining a little towards the ſouth; ſo as to form a wall with a ſouth aſpect. And thus may ſerve a double uſe, as coverings for the

[1] It will be alſo neceſſary to make the bottoms of the ſalt pits of alabaſter, or ſome other ſtrong cement that will not eaſily break up; by which means the ſalt may be drawn white and pure, as in Spain and Portugal, and not dirty and grey, as in the French marſhes.

pits

pits in wet weather, and as reflectors of the ſun's heat upon them in dry weather. For when they are let down they will prevent the rain from mingling with the ſtrong brine contained in the ſalt pits; and when they are drawn up in ſun ſhiny weather, they will ſtrongly reflect the rays of the ſun upon the brine contained in the pits, and thus greatly promote the evaporation of its aqueous particles. The hinges on which the reflectors turn may be fixed about eight or ten inches from the ground. By which means, when the reflectors ſtand upright, there will be an opening left beneath them, through which the air will continually flow in a briſk current, and greatly encreaſe the evaporation of the water.

IN order alſo that no diluted brine may flow into the ſalt pits during rains, it will be neceſſary at ſuch times to ſtop the narrow winding channel leading to the pits, by a little ſluice. This channel alſo muſt be made very narrow, and every where covered over with boards. And there muſt not be a pond at the entrance of the ſalt pits, as in the French marſh, but only a narrow covered trench, running parallel to the ſide of the pits which is oppoſite to the reflectors. And the pond, which

which forms the entrance of the pits in the French ſalt marſh, muſt in this be detached from them; and inſtead thereof muſt be formed a fourth brine pond, communicating with the third by a long narrow channel.

If theſe contrivances ſhould be reduced to practice in England, the ſalt will probably cryſtalize there much faſter than in the French ſalt marſhes. And the brine may be kept as deep and even deeper there than in the French ſalt pits. In which caſe the Engliſh ſalt marſh will require fewer pits than in the method propoſed in the foregoing propoſition. And if a ſhower or two of rain chances to fall, the operation will only be retarded while the rain continues; whereas in the French open work, ſuch a quantity of rain falling often puts a ſtop to the work for two or three days, as all the freſh water that fell muſt again be exhaled, before any ſalt can be formed.

But in order to prevent the weaker brine from being diluted with rains; and in order alſo to provide a ſufficient quantity of brine which may always be ready to ſupply the place of that which cryſtalizes in the ſalt pits, it may be neceſſary to dig in the earth four

four ciſterns adjoining to the brine pits above propoſed, which may be made tight at the bottom and ſides with brick and clay, into which the brine in the ſalt ponds may be admitted when the rainy weather comes on, ſo that the brine of different degrees of ſtrength may run into ſeparate ciſterns, and may again be pumped out of them into the ſeveral ponds from which it was drawn, as ſoon as the weather grows dry, and the freſh water, which fell into the pits, hath by proper drains been firſt diſcharged out of them.

As to the ſalt water in the reſervoir, if it ſhould not be found neceſſary to preſerve it from rains in ciſterns; when ſo much rain falls, as to make it freſher than ſea water, it may be let out, and ſea water admitted into its place. And in order to promote the evaporation, and to make the ſalt water in the reſervoir fitter to ſupply the firſt brine pond with brine of a due ſtrength, it may be proper, by means of a ſmall fire engine, continually to force up the ſalt water in the reſervoir as often as occaſion requires, and by means of a diverger fitted to the engine to make it deſcend again into the reſervoir like a ſhower of rain; by which means the eva-

poration of the watery vapours will be greatly promoted, after much the ſame manner as is practiſed at ſeveral ſalt works in Germany where the brine is very weak.

And thus by augmenting the force of the ſun's heat, and of the air, and by promoting the evaporation of the watery vapours, and by preventing the brine from being diluted with rain, it is very probable, that during the ſummer ſeaſon double the quantity of ſalt might be prepared at an Engliſh work with theſe contrivances, that is now uſually prepared at a French ſalt marſh of equal magnitude.

PROP. IV.

In ſeveral parts of England large quantities of excellent bay ſalt may, with great eaſe, be prepared from the natural brine of ſalt ſprings, and alſo from rock ſalt diſſolved in weak brine, or ſea water.

In Cheſhire, where they have natural brine almoſt fully ſaturated with ſalt, if they ſhould think proper to extract bay ſalt from this brine, it may be pumped directly into ſalt pits (without any previous preparation) there to be wrought with reflectors, as deſcribed under

under the foregoing propofition. Only, if there be any ochre or mud mixed with the brine, it may be proper to draw it firft into covered refervoirs or cifterns, there to ftand till thefe impurities are fubfided, and from thence to let it out into the falt pits as occafion may require.

BUT if, as it commonly happens, the brine be not fully faturated with falt, then it may be expofed to the fun and air in brine ponds with reflectors fitted to them until it be reduced to a faturated brine, after which it may be received into the falt pits. Or elfe the weak brine may be fully faturated with rock falt, where that can be had cheap, or even with white falt, if due encouragement be given by the legiflature. Or where there is plenty of rock falt and no brine, frefh water, or fea water (if it can be conveniently had) may be faturated with it, and reduced to bay falt in falt pits with reflectors as before defcribed.

THUS large quantities of bay falt may be made from natural brine at one operation, as is practifed at the ifle of May and in feveral parts of the Weft Indies. Of the quantities which can thus be extracted fome con-

conjectures may be made from the following calculations.

SUPPOSE a salt pit sixteen feet square. A work consisting of eighteen pits of the same size, placed all in a row, will be ninety five yards long, and will be somewhat larger than the salt pits of the French marsh before decribed. The area of each of these pits will be two hundred and fifty six square feet, and if they are covered a quarter of a foot deep with brine, then each pit will contain sixty four cubic feet of brine. But from [1] Dr. Baynard's experiments, a cubic foot of common water weighs exactly seventy six pounds troy. Therefore sixty four cubic feet weighs $64 \times 76 = 4864$ pounds troy. Supposing therefore each pound, or twelve ounces, of brine to contain three ounces and an half of salt, then 4864 pounds of brine will contain 17024 ounces or 1064 pounds averdupois of salt, and eighteen pits of the same dimensions 19152 pounds, which is exactly 228 bushels of salt, each weighing eighty four pounds averdupois.

BUT as a pound troy, or twelve ounces, of water, will dissolve more salt than three ounces and an half; if therefore the pits be filled

[1] See his *Exp.* made at Oxford; in the *Ph. Tr.*

filled to the depth of three inches with fully ſaturated brine, more ſalt will be contained in them than here ſuppoſed. If it therefore be granted, as many affirm, that a gallon, ale meaſure, of the ſtrongeſt Cheſhire brine, which is almoſt fully ſaturated, holds three pounds averdupois of ſalt (which is very nigh a pound of ſalt to three pounds of water) the 7059 $\frac{3}{47}$ gallons of fully ſaturated brine, ſuppoſed as before to be contained in the eighteen ſalt pits, will hold ſomewhat more than 21177 pounds, or two hundred and fifty two buſhels nine pounds of ſalt.

IN order to eſtimate the time required to prepare the above quantity of ſalt, let it be ſuppoſed (as with great reaſon it may) that in dry ſummer weather, half an inch depth of water will, one day with another, exhale from the ſalt pits when wrought with reflectors. Then three inches depth, the quantity of water contained in the brine, will be exhaled in ſix days; ſo that at the end of ſix days all the ſalt, contained in the brine, will remain dry at the bottom of the pits; which, according to the firſt ſuppoſition, is two hundred and twenty eight buſhels of bay ſalt; and, according to the ſecond, ſomewhat more than two hundred fifty two buſhels. And if we divide thoſe

quantities by ſix, the number of days in which all the water is exhaled, we ſhall find that, according to the firſt ſuppoſition, thirty eight buſhels, and, according to the ſecond, ſomewhat more than forty two buſhels of bay ſalt may be daily prepared in dry ſummer weather, in a work of the above dimenſions.

THE ſame calculations alſo ſhew the quantity of ſalt, which may be prepared from ſea-water in a ſalt marſh, where the pits are of the dimenſions above ſuppoſed; for in both caſes the ſalt pits muſt be kept conſtantly filled with a fully ſaturated brine. But if only half the quantity here ſuppoſed, viz. twenty one buſhels, or 1764 pounds of ſalt, can be made every dry ſummer day in a ſalt marſh of the above dimenſions, it is as much as is commonly made every day from brine in a ſaltern whoſe boyler contains eight hundred gallons.

PROP. V.

Bay ſalt may be prepared in England by the foregoing methods at a very moderate expence, equal in goodneſs to the beſt foreign bay ſalt, and in quantity ſufficient for the conſumption of all the Britiſh dominions.

IF

If in the firſt place, we compare the French ſalt marſh with the Engliſh ſaltern for boiling white ſalt, we ſhall find the expence of making the former much leſs than that of making the latter; in which the expence of boiling-houſes, hot-houſes, furnaces, ſalt pans, &c. is very conſiderable; and which alſo frequently require large ſums to be laid out on them to keep them in repair; whereas the French marſh requires very little repairs. Beſides, the expence of coals or other fewel is very great in the Engliſh ſaltern, which is all ſaved in the French bay ſalt work; and the expence of labour will be more in proportion to the quantity of the ſalt made in the Engliſh white ſalt work than in the French ſalt marſh. And for theſe reaſons; though the French bay ſalt is better than the Engliſh boiled ſalt, yet it can be made for ſeven or eight ſhillings a tun, which is little more than one third of the price for which white ſalt can be made in the moſt commodious parts of Great Britain.

If again we compare the French ſalt marſh with the Engliſh marſh, as propoſed under Prop. the ſecond, we ſhall find that where the ſituation is equally convenient,

difference of the expence in making them will be very inconſiderable. For as the partitions between the ſalt pits, and the trench and ſluice which admit the ſea water, and the walls between the ponds, are the moſt expenſive parts of the work; if therefore the Engliſh work be one fifth part more in ſurface than the French work, it will not require above one tenth part more expence to make it, than to make the other. And this ſmall difference in the prime coſt of the two works, will occaſion but a very trifling difference in the expence of making ſalt in them; eſpecially as the works, when finiſhed, will require little repairs for twenty or thirty years.

The expence of the Engliſh ſalt marſh will indeed be conſiderably increaſed by the additional contrivances propoſed under the third Prop. The moſt expenſive of theſe will be the reflectors, which I am informed by a good judge, if made of ſtrong ſail cloth ſtretched on frames, and painted white, and properly fixed to poſts, ſo as to cover eighteen pits of ſixteen feet ſquare, might probably coſt 50 *l.* or at the moſt 60 *l.* And ſhould all the other contrivances coſt 60 *l.* more, or even double that ſum; this addi-

additional expence would be very quickly accounted for in the profit of the work, as it is probable that double the quantity of ſalt might be made with theſe contrivances, that could be made without them. And the additional labour, which theſe contrivances would occaſion, would make very little encreaſe of expence, as it would all be performed when no ſalt is drawn, and conſequently when the labourers have little elſe to do.

As to the work propoſed under Prop. IV. for making bay ſalt from natural brine; twice as much ſalt might be prepared in it in one day (according to the foregoing calculations) as is uſually made in a Cheſhire ſaltern, whoſe pan contains eight hundred gallons. Although the ſaltern would require much more money to erect it, and to keep it in repair, beſides the expence of coals; which is the heavieſt article, coſting oftimes above two thirds of the value of all the ſalt prepared with them.

ALL theſe things therefore conſidered, it may with reaſon be preſumed that bay ſalt may be made in ſeveral parts of Great Britain, nearly as cheap as it is now made in France. And as the French and

other foreign ſalt muſt be charged with a conſiderable freight when brought to the Britiſh market, it is very probable that bay ſalt made in great Britain might be afforded cheaper there than French or any other foreign ſalt; eſpecially as there is 1*s.* $1\frac{1}{3}$*d.* paid more in duties for every half hundred weight of foreign ſalt, than for the ſame quantity of Britiſh ſalt conſumed in England[1]; which ought to be conſidered as a bounty to the Britiſh manufacturer of bay ſalt. Moreover, the law now allows three buſhels duty free, for every wey (or forty buſhels) of Britiſh ſalt carried coaſt-wiſe; which allowance will not only make up for the waſte in carriage, but will alſo pay the expence

[1] By the laws as now eſtabliſhed, white ſalt and other ſalt of Britiſh manufacture conſumed in England pays a duty of 3*s.* 4*d.* per buſhel, weighing fifty ſix pound.

But bay ſalt, and other foreign ſalt there conſumed, pays a duty of 6*s.* 8*d.* per buſhel, weighing eighty four pound. So that fifty ſix pounds of foreign ſalt pays 4*s.* $5\frac{2}{3}$. in duty; from which 3*s.* 4*d.* being deducted, there remains 1*s.* $1\frac{1}{3}$*d.* which is paid for fifty ſix pound of foreign ſalt more than for the ſame quantity of Britiſh ſalt conſumed in England. In both caſes an allowance is made for prompt payment. In Scotland the exciſe upon Britiſh ſalt as well as foreign ſalt there conſumed, is only half of that paid in England.

And all ſalt applied to curing ſuch fiſh as is exported to foreign markets, is in both parts of the united kingdom free from duty.

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of carrying the ſalt to market, to moſt parts of England. The laws therefore, as they now ſtand, are extremely favourable to the Britiſh manufacturers of bay ſalt, who, together with the public, would, in all probability reap great advantage by making ſalt works, ſuch as before propoſed. And ſuch numbers of theſe works might be made at proper places along the Britiſh coaſts, and nigh brine pits where fuel is ſcarce, as would afford bay ſalt enough for all the occaſions of Great Britain; and might even furniſh an article for exportation in thoſe ſhips which are ſent from thence empty to Denmark, Norway, and into the Baltick, for hemp, flax, iron, timber, and other commodities of thoſe countries.

IT remains now to ſhew, that bay ſalt, thus made in Great Britain, will, anſwer all the purpoſes of foreign bay ſalt, and will be equally good for curing fiſh and fleſh, and for all other culinary uſes.

As to the ſea ſalt, no one will call this in queſtion, ſince it is made from the ſame water as foreign marine bay ſalt, and the method propoſed for making it appears to be at leaſt as good as that which is practiſed by foreigners. And it hath already been found

by experience, that bay ſalt made in Hampſhire is not inferior to foreign bay ſalt for the abovementioned uſes. And where natural brine is ſufficiently pure, as at Droitwich, there is no doubt but that an excellent bay ſalt might be made from it at one operation, as is practiſed in the iſle of May, and in other hot countries. But if there be much calcarious earth, or other earthy impurities mixed with the brine, as in Cheſhire; ſuch brine will afford a better ſalt if it is only of a moderate ſtrength, ſo that it may remain a conſiderable time in brine ponds, there to mellow, and to heighten into a fully ſaturated brine, and to depoſite its earthy impurities, which would be very prejudicial to the ſalt if mixed with it, as will be more fully explained hereafter.

PROP. VI.

In ſeveral of the Britiſh colonies in America, bay ſalt might, with little expence and trouble, be prepared from ſea water, in quantities ſufficient to ſupply the American fiſheries, and all the other occaſions of thoſe colonies, ſo as to become a conſiderable branch of their trade.

IT

IT ſeems a truth deſerving the conſideration of every friend to Great Britain, that its colonies in America might be made capable of furniſhing it with almoſt all kinds of natural commodities, which it wants of foreign production; as wine, oil, ſpices, tea, ſilk, hemp, iron, and other metals. Salt is alſo a commodity, which thoſe colonies might be made to yield in great abundance; and is ſo much wanted for their own conſumption, and ſo neceſſary for the ſupport of their fiſheries, that it ſeems ſtrange that its manufacture ſhould have been there ſo long neglected; eſpecially as it might be made in moſt of thoſe colonies at a very ſmall expence. For all the ſea coaſts of Georgia, Carolina, and Virginia, and the iſles of Bermudas, lie between 31 and 38 degrees of latitude; ſo that their moſt northern parts are eight degrees nearer the line, than thoſe coaſts where the greateſt part of the French ſalt is made. The grapes, which in France are not ripe till September, in Carolina are ripe in June, or the beginning of July. And in all thoſe colonies the heats in ſummer are more exceſſive than in any part of the bay of Biſcay, and the draughts oftimes very diſtreſſing. So that there is no danger of wanting

wanting either ſun or fair weather for making ſalt on all that vaſt extent of coaſt; and even much farther northwards, as in New York, New Jerſey, and New England. In ſuch parts therefore of theſe coaſts as have a convenient ſituation, marine bay ſalt might be made with great eaſe, and in very great abundance, and probably at as cheap a rate as in any other part of the world; ſo that thoſe colonies might be ſupplied with ſalt of their own manufacture, at a much cheaper price, than they have it from the Cape de Verd iſles, and Salt-Tortuga; and would never more be put to the neceſſity of bringing it from Sardinia and Portugal, as they now are in this time of war. For it is now found too hazardous an undertaking to go to the iſle of May, or Tortuga, to make ſalt, as ſhips lying ſo long in open roads are too much expoſed to the enemy. And in times of peace the length of the voyage, the danger of the ſeas in open roads, the expence of making and ſhipping the ſalt, and the uncertainty of getting a loading, muſt make the ſalt from thoſe iſlands come much dearer to the Britiſh colonies, than that of their own manufacture [2].

[2] In times of peace bay ſalt is ſold in bulk in the Bri-

As to Jamaica and the Caribbee iſlands, which lie between the tropics, the heat of the ſun is there ſo intenſe, and the weather ſo ſettled during the greateſt part of the year, that thoſe colonies might, with a very little trouble and expence, be ſupplied with marine bay ſalt of their own manufacture.

If therefore in future times, the Britiſh dominions, either in Europe or America ſhould want bay ſalt of their own manufacture, fit and ſufficient for all their occaſions, and at as a cheap or even a cheaper rate than they now have it from foreign markets, it may be concluded that the ſcarcity proceeds, either from a want of induſtry in the Britiſh ſubjects, or elſe, for want of proper encouragements from their legiſlature.

tiſh colonies in North America, at a medium for about 15*d.* per buſhel (and cannot well be afforded for leſs, as I am aſſured by gentlemen of experience) and now in time of war above double that ſum is paid for it, and it can ſcarce be had at any price; although it might be made in thoſe colonies for 4*d.* per buſhel in times of war, as well as in times of peace.

THE

The ART of preparing WHITE SALT.

PART IV.

In which some methods are proposed for preparing white salt fit for preserving provisions.

ALTHOUGH it may be presumed, that if the rules before given be reduced into practice, the subjects of these kingdoms may be supplied with excellent bay salt of British manufacture, fit and sufficient for their occasions; yet nevertheless, I am desirous of proposing several improvements that may also be made in our methods of preparing white salt; which, if brought into use, may probably be of advantage not only to private undertakers, but also to the public. From what hath before been observed, it appears, that two very different kinds of white salt are required; the one for the

the uſe of the table, and the other as a condiment for proviſions. Its whiteneſs, dryneſs, and the ſmallneſs of its grain, are the properties which chiefly recommend the firſt kind; and its great ſtrength and purity, the latter. It is this ſtrong and pure kind of white ſalt which is wanted in the Britiſh dominions; and it is therefore my principal deſign here to conſider how this defect may be ſupplied; although inſtructions will at the ſame time be given how to prepare table ſalt, not only better in quality, but alſo at a leſs expence than it is now prepared by the common methods.

LEMMA I.

In the common proceſſes for making white ſalt, the ſalt is deprived of a conſiderable part of its acid ſpirit by the violent boiling uſed in its preparation.

THE Rev. Dr. Hales, to whom the world is indebted for many excellent diſcoveries, in the method which he hath publiſhed of making ſalt water ſweet and potable, hath given us the following experiments.

[1] HE diſtilled ſea water to a drineſs in glaſs veſſels, dividing the water as it came

[1] See his *Philoſ. exper.* pag. 12, 13, 14.

over

over into nine different portions. He obſerved that the firſt portion, which aroſe till the water began to boil, was pretty well taſted; but the ſeven portions which came next over while the ſea water in the retort was boiling, had all of them a flat, unſalt, nauſeous, dry, aduſt taſte. The ninth portion, which came over laſt, till the ſalt in the retort was diſtilled to a drineſs, was more harſh and diſagreeable than any of the reſt, taſting more of a kind of ſpirit of ſalt; but none of them had any taſte like bitterneſs or bitumen. Half a ſpoonful of each of theſe nine portions of diſtilled water being put into ſeparate glaſſes, to each glaſs was added two drops of a ſolution of pure ſilver made in aqua fortis, and diluted with ſpring water. This ſolution immediately cauſed white clouds in the clear diſtilled water, which were leaſt in the firſt portion, and nearly the ſame in all the others, except in the laſt, which had whiter and thicker clouds than any of the reſt. And theſe white clouds plainly diſcovered the diſtilled water to be impregnated with ſpirit of ſalt, by means of which the ſilver diſſolved in the aqua fortis was precipitated.

[2] By other experiments, the ſame learned gentleman found that the ſpirit of ſalt ariſes in greater quantities in proportion as the diſtillation is carried on farther[3]. He alſo obſerved, that when ſea water was diſtilled before it had corrupted, a third part of the water, which firſt came over, had no very conſiderable quantity of ſpirit of ſalt mixed with it, but might be uſed inſtead of freſh water. For though when firſt diſtilled, it gave white clouds with the ſolution of ſilver; yet after ſtanding in flaſks for three months, it no longer gave any white clouds, nor other marks of acidity. But the two remaining thirds of the water, which were laſt drawn off, after ſtanding three months, ſtill continued to taſte tart and rough, and gave manifeſt clouds with the before-mentioned ſolution.

[4] HE alſo diſcovered that ſea water after putrefaction, might be diſtilled with a boil-

[2] *Philoſ. exper.* pag. 38.

[3] The ſame work, pag. 39, 40.

[4] It ſeems reaſonable to believe, that when ſea water is evaporated by a boiling heat, it emits the acid fumes of ſalt ſooner and in larger quantities when freſh than after a putrefaction; becauſe while it is freſh and retains its viſcoſity, it requires a ſtronger heat to diſentangle its aqueous parts, and to reduce them into vapours. And by this ſtronger heat the acid ſpirit is alſo

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ing heat, till four fifths of it was come over before any conſiderable quantity of the ſpirit of ſalt would ariſe. But when the diſtillation was continued until the ſalt in the retort remained dry; that fifth portion of the water which laſt aroſe, was ſo ſtrongly impregnated with ſpirit of ſalt, that it taſted plainly acid, and not only precipitated ſilver from the before-mentioned ſolution, but alſo gave greater marks of acidity by turning ſyrup of violets red; which ſeveral other portions of diſtilled ſea water would not do, although they were ſufficiently impregnated with the ſaline ſpirit, to give white clouds with the ſolution of ſilver, as before related.

[5] THE excellent Mr. Boyle aſſures us, that when he diſtilled ſea water in a glaſs head and body with a moderate heat, till a conſi-

ſeparated from the ſalt, and raiſed when about a third part of the water is evaporated; but when, by putrefaction, the water hath loſt its viſcous quality, it boils, and this off in vapours with a leſs degree of heat; therefore no acid ſpirit is raiſed till four fifths of the ſea water is exhaled; (ſee Dr. Hales *Ph. exp.* pag. 31.) but then, the water remaining, being greatly loaden with ſalt, and thereby made thick and ponderous, it contracts ſuch an intenſe heat in boiling, as is ſufficient to ſeparate a conſiderable quantity of acid ſpirit from the ſalt, and to raiſe it along with the watery vapours.

[5] See his *Phil. works* abridged by Dr. Shaw, vol. iii. pag. 220.

derable

derable portion of it was drawn over; he could not find that this water, either by its taſte, or a more chemical examination contained any thing of ſalt in it; although it is well known, that he firſt applied the abovementioned ſolution in trials of this kind, and doubtleſs made uſe of it upon this occaſion. Theſe his experiments do no ways diſagree with thoſe of the Rev. Dr. Hales before related; for had Mr. Boyle applied a more violent heat, he would doubtleſs have found the diſtilled water impregnated with the acid fumes of ſalt, as in Dr. Hales's experiments.

AND that ſea water, when diſtilled in large alembics, after the common method, with quick fires, doth part with a conſiderable quantity of acid ſpirit, was long ago known to Mr. Hauton[6]; who in the method which he publiſhed of making ſalt water ſweet, very judiciouſly directs a certain earthy ſubſtance to be mixed with the diſtilled water, and gently to ſubſide therein; in order, as he ſays, "to blunt the points of the volatile "ſpirits of the ſalt, and to ſheath them, "and take away the force of their malign "ſharpneſs".

[6] *Ph. Tranſ. ab.* vol. ii. pag. 277.

And that the volatile acid of common ſalt may be eaſily ſeparated from its fixed alcaline principle, appears from an expermient of the illuſtrious Mr. Boyle, who by a long and artificial digeſtion of this ſalt, ſo ſeparated thoſe its two principles; that when this digeſted ſalt was placed in a gentle ſand heat without any addition, the ſpirit aroſe from it, pure, leaving the phlegm behind in the retort. Chemiſts have alſo taken notice, that common ſalt by being fuſed in a crucible acquires an alcaline quality, a large quantity of its acid ſpirit being diſſipated in the operation; and that if afterwards it be expoſed to the air, it eaſily runs *per deliquium*, much earth being left undiſſolved at the bottom of the veſſel; and that, after it hath been ſeveral times fuſed, if ſome powder of charcoal be added to it, whilſt in fuſion, a ſulphureous maſs is produced, as if it was mixed with common brimſtone[7].

But a much milder heat than is required to fuſe common ſalt, will ſeparate its acid

[7] See Hoffman's *Obſ. Phyſ. Chem.* Lib. ii. Obſ. xvi. If credit may be given to Glauber, he could in a few hours ſo change ſea ſalt, that it would acquire a fiery nature, and ſerve all the uſes of pot aſhes, and other lixivial ſalts.

ſpirit from its alcaline principle, as I was taught by the following experiments. I took about half a pound of pure cryſtals of bay ſalt from St. Ubes, and diſſolved them in pure water; ſeveral portions of this ſolution I mixed with ſyrup of violets, and with the tincture of flowers of Cyanus, and obſerved that the blue colour of the ſyrup and tincture was not changed either green or red, but rather heightened by the ſalt. The reſt of the ſolution I boiled over the fire briſkly in a clean iron pan, till moſt of the water was evaporated, and the ſalt remained in a ſolid form at the bottom of the pan, but ſtill retained ſome moiſture, and was not reduced to a perfect dryneſs. Some of this boiled ſalt being diſſolved in pure water, and then mixed with ſyrup of violets or the tincture of Cyanus, inſtantly turned the colour of thoſe liquors into a graſs green. This experiment was often repeated; and plainly ſhews, that the alcaline principle was predominant in this boiled ſalt, and that it had been deprived of a conſiderable portion of its acid ſpirit by the heat applied to it during its coction.

FROM all theſe experiments we may therefore conclude, that the volatile acid

ſpirit, may eaſily be ſeparated from the fixed alcaline principle of common ſalt, by more ways than thoſe practiſed by chemiſts in the diſtillation of thoſe acid ſpirits; and that when ſalt water is expoſed to the fire, very little or none of the ſpirit of ſalt ariſes while the heat applied is conſiderably leſs than that which is neceſſary to make rain water, or any other pure water boil; but if a greater heat be applied, ſo that the water with the ſalt diſſolved in it be kept continually boiling till the evaporation be finiſhed: then, during that part of the coction in which the water is only weakly impregnated with ſalt, no acid ſpirit, or very little ariſes[8]; but as ſoon as the water is ſo far evaporated, that what remains contains about a ſixth part; or, if the water be viſcid, like ſea water, about a twentieth part of ſalt, it then acquires ſo great a heat in boiling as is ſufficient to ſeparate a conſiderable quantity of acid ſpirit from the ſalt, which ſpirit therefore flies off along with the watery vapours. And as the brine, during the eva-

[8] Theſe calculations are made upon a ſuppoſition, that the ſea water uſed by Dr. Hales and Mr. Boyle in the above-mentioned experiments contained $\frac{1}{30}$ part of ſalt. For $30 - \frac{4}{5}$ of $30 = 6$. And $30 - \frac{5}{3}$ of $30 = 20$.

poration,

poration, continually becomes more fully ſaturated with ſalt, and grows continually more ponderous, it therefore continually acquires a more intenſe heat in boiling, which greater degree of heat ſeparates a greater portion of acid ſpirit from the ſalt; ſo that the ſpirit ariſes ſtill in greater quantities, in proportion as the evaporation is carried on farther; and the ſalt being thus deprived of part of its acid ſpirit, acquires an alcaline quality, and is alſo conſiderably diminiſhed in quantity, when the coction is continued till all the water is evaporated.

THESE obſervations hold true in the common proceſſes of preparing ſalt by coction. For all who are acquainted with the method of making white ſalt unanimouſly agree, that the ſalt contained in brine or other ſalt waters is conſiderably diminiſhed in quantity, when thoſe waters are made to boil violently towards the end of the proceſs, after the ſalt hath begun to cryſtallize; at which time the heat of the ſaturated brine, if kept boiling, is much more intenſe than that of boiling water. But the bittern which remains in the pan after the ſalt hath been extracted by ſo intenſe a heat, is found more in quantity, than when a moderate heat is

 applied;

applied; being increaſed by the alcaline part of common ſalt deprived of its acid ſpirit, by the violent coction. The ſalt made with this intenſe heat, is of a ſmall looſe irregular grain, and quickly grows moiſt in the air; for which reaſon, the artiſts ſay, that it is not well cleared of the freſh. In order therefore, to obtain a larger quantity of ſalt, and of a better kind, they conſtantly ſlacken their fires, and boil very gently, as ſoon as they perceive the ſaline cryſtals begin to form in the brine. But they do not thus prevent the ſpirit of ſalt from exhaling in conſiderable quantities. For although the ſaturated brine only ſimmers or boils very gently, yet it then retains ſuch a heat as is ſufficient to drive off a conſiderable portion of this ſpirit; and a conſiderable portion of it muſt alſo have exhaled before the time that the workmen ſlacken their fires, as appears from the foregoing experiments. So that white ſalt prepared after the common methods, muſt be deprived of a conſiderable portion of its acid ſpirit, by the violent coction uſed in its preparation.

LEMMA II.

Moſt kinds of white ſalt are rendered impure by the mixture of various heterogeneous ſubſtances.

IN the common proceſſes of boiling ſalt from ſea water, a large quantity of calcarious earth, called ſcratch, is obſerved to ſeparate during the coction. Part of this earth cloſely adheres to the bottom and ſides of the boiler, and there, forms a ſtony cruſt. Another part of it floats looſe in the brine, in the form of a ſubtile powder, until it is caſt to the corners of the boiler, where, being no longer agitated by the motion of the liquor, it ſubſides into ſmall flat pans placed there to receive it. But all of it cannot after this rude method be ſeparated from the brine; a conſiderable quantity of it ſtill floats therein, until it mixes with the ſalt, and together with it is drawn out of the boiler.

MOST other kinds of ſalt water are greatly contaminated with the ſame calcarious earth; it abounds in the natural brines both of England and Germany, ſome of them containing as much of it as ſea water does of ſalt;

and it is an advantage almoſt peculiar to the Droitwich brine to be entirely free from any mixture of this terreſtrial matter. Salt therefore boiled from brine, as well as from ſea water, is ſeldom without a mixture of this calcarious earth; ſince no greater care is uſed in ſeparating it from natural brine than from ſea water, in boiling them into ſalt.

THE ſame may alſo be affirmed of the ſalt refined from a ſolution of the Engliſh foſſil ſalt; in boiling of which, this earth is obſerved to float about, and is collected into ſcratch pans, as from other ſalt waters.

BESIDES this calcarious ſubſtance, moſt kinds of brine hold a ferruginous earth or ochre, which is ſometimes mixed with the ſalt, and renders it of a dirty colour. At ſeveral of the Cheſhire ſalt works, where they uſe a very ſtrong brine, the firſt draught of ſalt, or clearing of the pan as they call it, is rendered ſo impure by this, and other heterogeneous mixtures, that they throw it away as uſeleſs.

THE earthy ſubſtances mixed with ſalt, may eaſily be diſcovered by diſſolving it in pure water, and ſuffering the ſolution to remain quiet, till all the groſs ſubſtances which were mixed with the ſalt have ſubſided to the

the bottom of the veſſel. Moſt kinds of boiled ſalt that I have had opportunities of examining, as ſea ſalt, Cheſhire brine ſalt, rock ſalt refined in Cheſhire and Ireland, when thus diſſolved in pure water, conſtantly let fall a white earthy ſediment in conſiderable quantities; and in moſt of their ſolutions I have likewiſe obſerved large ſcales of ſcratch which had been diſunited from the ſides of the ſalt pan. On moſt of theſe ſolutions there alſo aroſe a frothy ſcum, which was much more copious, and of a more duſky colour on the ſolutions of thoſe ſalts which were mixed with butter and other additions, than of thoſe which had been prepared without them. I have alſo obſerved coal duſt, ſand, and other groſs impurities frequently mixed with ſeveral kinds of white ſalt.

BUT beſides the earthy and other groſs ſubſtances found mixed with white ſalt; it is commonly rendered ſtill more impure by a mixture of ſalts of a different nature. For in the proceſs of boiling ſalt from ſea water, it was obſerved that a conſiderable quantity of a ponderous, ſharp, unctuous, bitter liquor remained in the pan, after all the ſalt was extracted; and that a conſiderable quantity

tity of the ſame bitter liquor alſo drained from the ſalt after it was drawn out of the pan. Now, although thoſe who boil ſea ſalt ſuffer the bitter liquor to drain from it for ſeveral days; yet it cannot be imagined that all the bittern is, after that manner, ſeparated from the ſea ſalt; a conſiderable quantity of it doth undoubtedly ſtill adhere to the ſalt in a liquid form; and a large quantity of the bitter purging ſalt is often reduced into cryſtals along with the common ſalt; and ſometimes may be diſcovered in it even by the taſte. And thoſe who know how difficult a matter it is to refine nitre, and other ſalts, and ſeparate them one from another, and render them pure by cryſtallization, will readily conclude, that it is almoſt impoſſible to ſeparate the common ſalt entirely from the other ſalts contained in ſea water, after the tumultuary manner in which the proceſs of boiling ſea ſalt is uſually performed.

Moreover moſt kinds of brine ſalt are probably alſo rendered impure by a mixture of the bitter purging ſalt, and other calcarious ſalts. The bitter purging ſalt is obſerved greatly to abound in the bowels of the earth, and to impregnate, not only the ocean,

ocean, but also ſeveral lakes, as the lake of Sodom or Dead Sea, whoſe waters are thereby rendered extremely bitter. It is probably this ſalt that gives moſt of the ſprings in Arabia, and ſome other parts of Aſia their bitter taſte, and renders them unpotable. And in England, we find a vaſt number of ſprings impregnated therewith, and together with it almoſt conſtantly to hold a muriatic ſalt; ſo that this bitter ſalt and common ſalt are uſually found together diſſolved in the ſame water; as in the brine of Cheſhire, if in this particular, credit may be given to Doctor Leigh. Rock ſalt likewiſe often holds a mixture of this bitter ſalt; it is diſcovered by the taſte in the foſſil ſalt of Armenia, and renders the ſalt of the mountain Had-deffa ſo bitter, that it is unfit for domeſtic uſes until it hath undergone an accidental purification[1]. And that moſt of the brine ſprings in Germany hold a kind of bittern, we are aſſured by Dr. Fred. Hoffman; although from his experiments their bittern ſeems to contain much more of the ſharp pungent muriatic calcarious ſalt, than of the bitter purging ſalt

[1] See note from the Rev. Dr. Shaw in the introduction.

before deſcribed. It can therefore ſcarce be imagined, that the Engliſh brine ſalts are wholly free from a mixture of theſe calcarious ſalts of the bittern; eſpecially when it is conſidered that the brine ſalt makers are not accuſtomed to throw away any of their liquor; but conſtantly mix the leach brine, which remains in the pan, or drains from the ſalt, with the brine freſh drawn into the pan, and ſo boil them up together into ſalt.

As to the refined rock ſalt made in Cheſhire, it not only contains all the heterogeneous ſalts of the native foſſil ſalt; but alſo, all the bitter ſalts of the brine or ſea water, with which the foſſil ſalt is refined. For neither do the refiners uſually throw away any of their leach brine; but mix it in the pan with their freſh ſolution, and therewith reduce it into ſalt, hardening up all together in their hot houſes.

Besides theſe calcarious ſalts, moſt kinds of boiled ſalt are alſo mixed with a fixed mineral alcali. This alcaline ſalt may eaſily be diſcovered in the marine bittern by ſyrup of violets, which it inſtantly turns green; and in the ſame manner it may probably be diſcovered in moſt kinds of leach brine, by thoſe who have opportunities of trying them.

them. I have frequently mixed various kinds of white ſalt, as ſea ſalt, brine ſalt, and refined rock ſalt, with about an equal weight of pure water; and after the water had diſſolved near as much of the ſalt as it could keep ſuſpended, have poured off the clear ſolution; and, when the ſalt had not before been long expoſed to the air, almoſt conſtantly obſerved that its clear ſolution prepared in the foregoing manner, being mixed with the tincture of flowers of Cyanus, turned it from a fine blue, to a green colour; which change of colour plainly diſcovered that the ſalt contained ſome mixture of a mineral alcali. Some of theſe ſolutions would inſtantly change the colour of the tincture, but others not till after twelve, or twenty-four hours, and then only to a pale green. But the ſolution of fine Portugal ſalt made after the ſame manner, had no ſuch effect upon the tincture, but rather heightened its blue colour; and this colour it retained much longer when mixed with the laſt mentioned ſolution, than when mixed with pure water in the ſame proportion. In making theſe experiments care ſhould be taken that the ſolutions be perfectly clear, and free from any mixture of calcarious

earth;

earth; otherwiſe the change of colour may proceed from the alcaline earth, and not from any perfect alcaline ſalt. From the experiments made by boiling pure bay ſalt as before related[2], it appears that the alcaline ſalt found mixed with white ſalt, may ſometimes be the alcaline principle of common ſalt deprived of its acid ſpirit by violent coction. At other times, it may have exiſted in the form of an alcali in the ſalt water before its coction. In both caſes its nature and effects will be nearly the ſame.

Besides the various kinds of ſalts and earthy ſubſtances before taken notice of; we are aſſured by Mr. Boyle, that common ſalt ſometimes participates of combuſtible ſulphur. That moſt kinds of natural brine contain a ſulphureous principle, is very certain; and this principle may ſometimes be of ſo fixed a nature, or ſo entangled with the ſalt, that it cannot eaſily ſeparate from it, and fly off in boiling. Altho' it is probable that moſt of the ſulphureous ſubſtance mixed with boiled ſalt may rather be artificial than natural; and may proceed from the butter and other unctuous ſubſtances uſed by many ſalt boilers; which incorpo-

[2] Under the foregoing lemma pag. 227.

rating

rating with the salt, eſpecially when it is burnt and rendered alcaline by violent heat, may with it form a kind of liver of ſulphur, as in the experiments before related[3]. The like may ſometimes happen when fat blood is uſed to clarify the brine.

ALSO flower, roſin, and many other additions which the operators uſe, ſeem ſcarce to have any good effect, but load the ſalt with a ſtill greater variety of impurities.

LEMMA III.

White ſalt, by the violent coction commonly uſed in its preparation, is rendered leſs fit for preſerving fleſh, fiſh, and other proviſions, than it would be if prepared with a more gentle heat.

IT is well known to chemiſts, that common ſalt, by means of fire may eaſily be reſolved into two principles; and of them again may be compoſed. Theſe principles are a fixed alcali, and a volatile penetrating acid ſpirit. To the laſt of theſe principles is owing the power and efficacy which ſalt hath upon animal ſubſtances; whereby it gently contracts and hardens their ſolid parts,

[3] See page 233.

reſtrains the inteſtine motions of their fluids, and ſo preſerves them from corruption. That the acid ſpirit of ſalt poſſeſſes theſe qualities in a moſt extraordinary degree hath long been known to anatomiſts; amongſt whom it hath been a ſecret to mix a few drops of it with the fermented ſpirits in which they preſerve their injections, and other curious preparations.

The Rev. Dr. Hales found that this acid ſpirit would prevent common water from putrifying. He alſo experienced that beef might be preſerved ſweet a conſiderable time in water, by mixing with it this acid in the ſmall proportion of three drops to an ounce of the water.

[4] "Into two ounces of the laſt portion " of the diſtillation to drineſs of ſea water, " the ſame gentleman put a ſmall piece of " freſh beef: and put beef alſo into the like " quantities of well-cured ſea water, (which " had no ſpirit of ſalt mixed with it) and " alſo of rain water. In ſeven days the two " laſt were become fetid and putrid, and " the water thick and cloudy; whereas, " the beef in the very bad ſea water (im- " pregnated with ſpirit of ſalt) did not pu-

[4] Dr. Hales *Philoſophical experiments*, pag. 15, 16.

" trify,

"trify, nor was the water turbid, but "clear as at firſt, though kept ſeven or "eight weeks with the fleſh in it. And it "was obſervable, that the reſtringent qua-"lity of the bad diſtilled ſea water was ſo "great, that it contracted the fibres and "blood veſſels of the beef, ſo that no blood "could iſſue out of them; as it did from "the firſt day from the beef in the other "glaſſes, which had good wholſome diſ-"tilled ſea water, or rain water in them."

THESE experiments ſufficiently ſhew the extraordinary efficacy of ſpirit of ſalt in preſerving animal bodies from corruption. But this ſpirit is of too ſharp and corroſive a nature, and too noxious to the human body to be uſed as a condiment for food, unleſs its too great acrimony be allayed by the alcaline principle of common ſalt. For this, as well as all other acids, ſtrongly coagulates the blood of animals, when mixed therewith: whereas, neutral ſalts have no ſuch effect; and ſeveral of them, when diſſolved in water, may even be injected into the veins of animals, without doing them any great prejudice. Common ſalt, moſt eſpecially, is found friendly to animal nature; its acid ſpirit being ſo tempered by its alcaline prin-

 ciple,

ciple, that, when mixed with blood, it is thereby prevented from growing too thin and putrid, to which it hath a natural tendency; and the texture of the blood is thereby alſo preſerved ſo intire, that for years it preſerves its gummy balſamic quality. This hath been experienced in beef pickle; the animal juices in which, after it had been kept for years, have coagulated by heat, as if they had been blood freſh drawn from a vein; and this pickle hath often been uſed by the ſalt boilers to clarify ſea water inſtead of whites of eggs. Common ſalt, therefore, as it is of a middle nature, between acids and alcalics, hath neither the bad effects of the one, nor of the other, upon the juices of animals. For, when mixed with blood, it does not coagulate it like acids; neither does it thin the blood and deſtroy its glutinous texture, and reduce it to a tabid corrupted ſtate, as all alcalies, whether fixed or volatile are found to do.

The alcaline principle therefore, of common ſalt, when ſeparated from its acid ſpirit, is ſo far from having any efficacy as a condiment, that on the contrary, it corrodes and diſſolves animal ſubſtances, and promotes their putrefaction. All alcalies are found

found to have theſe effects, eſpecially the more fixed kinds, as they ſtrongly attract unctuous and aqueous ſubſtances, and by that means quickly penetrate the fleſh of animals; inſinuating themſelves between its fibres, and diſſolving their coheſion; when mixed with the juices of animals, they alſo act violently upon the neutral ſalts which they contain, uniting to the acid principle of thoſe ſalts, and ſeparating it from the volatile alcali to which it before was joined, and thus exciting inteſtine motions in thoſe juices, and promoting their corruption. Surgeons, therefore, know no better cauſtic for corroding the fleſh of living bodies, than that which is compoſed of ſoap and quicklime. And thoſe who are employed in dreſſing leather, find nothing ſo proper to tender ſkins, and reduce their external parts to a ſemi-putrid ſtate, as lime mixed with water; in which they ſteep their ſkins in order the more readily to ſeparate the hair from them. Theſe obſervations ſufficiently ſhew the effects of lixivial ſalts and quicklime upon animal ſubſtances, and how by them the ſolid parts of animals are corroded, and their fluids rendered ſharp and thin, and the

whole quickly reduced to a ſtate of corruption.

And that the alcaline principle of common ſalt hath a very great affinity to the lixivial ſalt of vegetables is plain and evident, ſince it is of a fixed nature ſoluble in water, and hath the ſame effects with thoſe lixivial ſalts upon ſyrup of violets, and other blue tinctures of vegetables; like them it greedily imbibes the aereal moiſture, and with it runs *per deliquium*; and like them alſo it readily unites to the phlogiſtic principle of charcoal, and with it forms a ſulphureous maſs, as hath before been obſerved. The lixivial ſalt of vegetables will even ſupply the place of this alcaline principle; and when mixed with the acid ſpirit of ſalt, is with it converted into a neutral ſalt, which does not appear in any reſpect different from common ſalt[4].

[4] Except it ſhould be found that the ſolution of this factitious common ſalt, made in pure rain water, will not grow turbid when mixed with the ſolution of ſalt of tartar. In which particular it may probably differ from all kinds of marine ſalt, whether bay ſalt or boiled ſalt, that I have had opportunities of examiuing; whoſe clear ſolutions conſtantly grew white when mixed with the ſaid ſolution of ſalt of tartar, contrary to what is aſſerted by Monſ. du Cloſs in the *Mem. de l'Acad. Royale des Sciences*. And theſe ſolutions, thus mixed together,

Com-

COMMON ſalt therefore owes its property of preſerving animal ſubſtances ſolely to its acid ſpirit; and in proportion as it hath more or leſs of this acid, it is more or leſs ſtrong; that is to ſay, it is more or leſs ſharp and pungent to the taſte, and hath a greater or leſs power of preſerving animal bodies from putrefaction. For it appears, that ſalt, deprived of a conſiderable part of its acid ſpirit, may yet retain the form of ſalt, although it cannot then be eſteemed a perfect ſalt, but rather a kind of decrepitated ſalt, in which the alcaline principle is predominant. Such ſalt is commonly of a ſmall, looſe, irregular grain, and is diſpoſed to grow moiſt in the open air, and is ſaid

conſtantly depoſited a very light earthy ſediment, and in ſeveral of them, part of this earthy matter was alſo ſuſpended like a cloud; and more of the ſolution of tartar being added to the mixture after it became clear, it did not again grow white and turbid; which ſhews that common ſalt only contains a ſmall portion of this white earth which may thus be precipitated from it. I alſo obſerved a ſmall portion of a very alcaline earth to ſettle in the ſolution of the white ſalt prepared by violent coction from bay ſalt, after the manner before related. Salt after fuſion, being ſuffered to run *per deliquium*, hath alſo been obſerved to depoſite an earthy matter, as before related. All which obſervations ſeem to prove, that the alcaline principle of common ſalt is not all of it a perfect fixed alcaline ſalt; but that ſome part of it is an alcaline earth approaching to the nature of quicklime.

to be weak, becauſe of a flat taſte, and improper for curing proviſions for exportation into hot countries.

AND ſuch, in a greater or leſs degree, are moſt kinds of white ſalt now made, being deprived of a conſiderable portion of their acid ſpirit by the violent coction uſed in their preparation, as hath before been demonſtrated. And this is confirmed by the practice of the Cheſhire ſalt boilers; who, when they formerly boiled their ſalt in a very haſty manner, found it unfit for keeping, and only made it for preſent ſale. Whereas, now by uſing a much ſlower heat, they prepare ſalt much fitter for preſerving proviſions; and by applying more gentle fires than ordinary, they prepare their ſhivery ſalt; which is the ſtrongeſt ſalt, and of the firmeſt and largeſt grain of any that they make. So that in proportion as the heat made uſe of in boiling white ſalt is greater or leſs, a greater or leſs quantity of the acid ſpirit is diſſipated; the weakeſt ſalt being prepared by the moſt violent heat.

THE Britiſh ſalt boilers, therefore, though they have made ſeveral improvements in their art, have not yet brought it to the utmoſt perfection; for the heat which they

ſtill

ſtill uſe is ſo intenſe, that by it a conſiderable portion of the acid ſpirit of ſalt is waſted; and the ſalt which they prepare is always leſs ſharp and pungent than bay ſalt, which is extracted by a more gentle heat; and for this, and other reaſons, hereafter to be given, is leſs proper than bay ſalt for curing proviſions. The Dutch, therefore, when they would make a kind of white ſalt fit for preſerving proviſions, very prudently take care to waſte the water, in which the ſalt is diſſolved, by a very ſlow and gentle heat, not much greater than the ſolar heat in the warmeſt climates, and by this means they obtain a ſtrong and vigorous ſalt, fully ſaturated with its acid ſpirit, and extremely proper for the uſes for which it is intended. For by ſuch a heat none of the ſpirit of ſalt is diſſipated, as appears from the experiments of Mr. Boyle and others, before related.

LEMMA IV.

The heterogeneous ſubſtances which are commonly mixed with white ſalt, render it leſs proper for preſerving proviſions, than it would be if ſeparated from them.

THE heterogeneous ſubſtances found mixed with moſt kinds of white ſalt are chiefly the

the calcarious earth called ſcratch, the bitter purging ſalt, and the muriatic calcarious, and alcaline ſalts before deſcribed.

THE calcarious earth which commonly abounds in boiled ſalt (and particularly in ſea ſalt, and moſt kinds of brine ſalt uſed in England) can no ways be proper for preſerving meat, approaching too near to the nature of lixivial ſalts and quicklime[1]. A ſubſtance of ſo alcaline a nature as ſcratch, can therefore in no wiſe contribute to preſerve the fleſh of animals; but, on the contrary, muſt rather corrode and deſtroy it, and promote its putrefaction.

AND hence it probably is, that the Droitwich ſalt, which is perfectly free from ſcratch, hath, by impartial judges[2], been eſteemed a ſtronger ſalt, and fitter for preſerving proviſions, than any kind of brine ſalt, prepared after the ſame way with it, in other parts of England.

As to the bitter ſalt, and the muriatic calcarious ſalt of bittern, of all neutral ſalts they are ſoluble in the leaſt quantity of water, and moſt greedily imbibe the aereal moiſture, and moſt readily unite to unctuous

[1] See part ii. chap. ii. § 3.

[2] As by Dr. Liſter and others.

ſub-

ſubſtances. So that when mixed with common ſalt, they diſpoſe it to relent and grow ſoft in the open air; and when applied with it to the fleſh of animals, they prey upon the fat, and with it unite into a kind of ſoap; they alſo do not ſuffer the ſalt to fix and harden in the meat, but diſpoſe it to diſſolve with the juices, and to run out with them in pickle; and the meat, being thus deprived of its fat and juices, is left open and ſpungy, ſo that the air eaſily penetrates and corrupts it.

The fixed alcaline ſalts, ſo frequently mixed with white ſalt, will have the ſame effects upon the fleſh of animals with the bitter and calcarious ſalts before related; moreover they will corrode the ſolid parts of animals, and promote inteſtine motions in their fluids, and render them thin and acrimonious, as hath before been explained. And to theſe alcaline ſalts ſeem chiefly owing the diſagreeable red colour, and tabid ſlime, frequently obſerved in beef, that hath been pickled with weak and impure ſalt.

Those therefore who prepare brine ſalt in England, ſeem guilty of a capital error, when they mix the leach brine which drains from the ſalt, or remains in the pan after the

the proceſs is finiſhed, with the brine freſh drawn from their ciſtern, and boil them up together into ſalt. For by this means they render their ſalt impure, and leſs fit for domeſtic uſes; as it hath mixed with it a much greater proportion of alcaline, bitter, and calcarious ſalts, than it would have if the leach brine was either thrown away, or applied to other uſes.

THEY alſo commit a yet greater miſtake, who, when they refine rock ſalt with ſea water, do no throw away their leach brine, or bittern, but mix it in the pan with their ſolution, and harden up all together into ſalt. And it ſeems entirely owing to this very faulty method, that the Cheſhire foſſil ſalt refined with ſea water, is of a worſe quality than their brine ſalt. For as their brine is only a ſolution of rock ſalt made in the bowels of the earth, often in very impure water, there could be no reaſon why the brine ſalt ſhould be better than the refined rock ſalt, if both were boiled after the ſame manner; the rock ſalt having firſt been diſſolved, not in ſea water or impure brine, but in purer rain or river water.

SEA ſalt therefore prepared by the heat of the ſun, as it is more free from ſcratch and the ſalts

ſalts of the bittern, than moſt kinds of white ſalt, is more proper for preſerving fleſh and other kinds of proviſions. For the marine bay ſalt is not extracted in a haſty and tumultuary way, but by a ſlow and gentle heat; ſo that when a certain portion of the water hath exhaled, the calcarious earth ſeparates from it, and ſubſides in the brine ponds, being depoſited before the brine enters the ſalt pits[3]. The brine, thus freed from its calcarious earth is, received into the ſalt pits, where the ſaline particles concrete together, and after they have united into large cryſtals, are drawn out pretty free from the ſalts of the bittern, which remain diſſolved in their watery vehicle. For chemiſts have obſerved, that when different kinds of ſalts are left to cryſtallize in a ſaline lixivium, thoſe conſtantly ſhoot firſt which require the largeſt quantity of water to diſſolve them; and very little of the more ſoluble ſalts will form into cryſtals while there remains a ſufficient quantity of water to keep them diſſolved. The bitter brine which remains in the ſalt pits, is frequently drained out of them. And if any of the ſalts of the bittern happened to be mixed with the bay ſalt, they are often waſhed out

[3] See the foregoing deſcription of the French ſaltmarſh, Part i. Chap. iv.

of

of it by rains, while it lies in heaps exposed to the air.

Thus a strong muriatic salt is obtained from sea water, turgid with its acid spirit, sufficiently freed from calcarious earth and bittern, and very proper for all culinary uses. For although it hath often a considerable quantity of slimy mud, clay, and sand mixed with it, which give it a dirty colour, yet these impurities do not penetrate the flesh of animals, but only adhere on its outside in a dirty crust, which may easily be washed off; so that they indeed make the meat more unsightly, but have no other bad effects upon it, and do not render the salt with which they are mixed unfit for preserving it.

As to the strong Dutch refined salt, it is certainly of all kinds of salt now made, the most pure, and in that respect the most proper for preserving provisions. For it retains scarce any calcarious earth, or salts of the bittern; it is also free from mud and other impurities with which bay salt is contaminated; and if it acquires any alcaline quality by boiling, that is corrected by a mild acid which is added to the brine. It is not, therefore, at all to be wondered at, that the Dutch white herrings cured with this salt, look much more

fair

fair and beautiful, and keep longer, and consequently sell for a better price, than those that are preserved with other kinds of salt.

PROP. I.

From sea water, fossil salt, or natural brine, to prepare a kind of white salt proper for curing fish, flesh, and other provisions.

BY the foregoing facts and arguments it seems to have been sufficiently demonstrated, that the common kinds of boiled salt are in some things deficient, in others redundant; that they want a considerable portion of their volatil acid, without which the other principles of salt have no efficacy as a condiment, but are like a dead body deprived of its quickening spirit; and that they abound with many impurities, as earths, sulphurious bodies, heterogeneous salts, hurtful additions of various kinds, ashes, soot, coal, &c. which, instead of preserving, defile and corrupt the flesh of animals to which they are applied.

MOREOVER, it seems to have been fully proved that those kinds of salt which are fully saturated with their acid spirit, and sufficiently depurated from heterogeneal

geneal mixtures, are extremely fit and proper for preserving fish, flesh, and other kinds of provision.

AND forasmuch as all kinds of common salt, when pure and perfect, are found to be of the same nature and to agree in the same qualities; from these premises may therefore be drawn the following conclusion: That any kind of common salt which is perfectly free from all heterogeneous mixtures, and hath not been deprived of any part of its acid spirit, is extremely fit and proper for curing all sorts of provisions.

THE requisites in the foregoing problem will therefore be fully satisfied, if from sea water, fossil salt, or natural brine, white salt be prepared free from all impurities, and no ways weakened by a dissipation of its acid spirit.

THIS may be fully effected at two operations. In the first of which, from the salt water must be prepared a good kind of white salt, more fully impregnated with its acid spirit, than salt boiled after any of the common methods. And in the second operation, the white salt thus prepared, must be refined from the impurities with which it is still mixed, and reduced to a purer and stronger

ſtronger kind of ſalt; after nearly the ſame manner that bay ſalt is now refined in Holland.

IN the firſt proceſs, if ſea water be uſed, the following method is recommended; by which a marine ſalt may be prepared better in quality, and alſo at a leſs expence, than by any of the methods of boiling ſea ſalt that are now in practice.

FIRST, let the ſea water be heightened into a ſtrong brine by the ſun, after the method practiſed in Hampſhire, and other parts of England; or (which will be a better and leſs expenſive method) in a ſalt marſh conſtructed after the French manner, from which large quantities of bay ſalt may be drawn at proper ſeaſons; and when the weather is leſs favourable, brine may be collected into large ciſterns there to remain until it is drawn out to be boiled into ſalt.

FOR this purpoſe a ſaltern muſt be erected adjoining to the ſalt marſh, and in it muſt be placed a large boiler or ſalt pan made of iron. The bottom of the pan may be of a ſquare figure, forty feet on each ſide, and its depth may be eighteen inches [1]. Or the

[1] If the pan is made of a ſquare figure, the ſcratch may conveniently be collected at its corners into flat

pan

pan may be made of a cylindrical form, forty feet in diameter, and eighteen inches deep; which is the moſt common ſize and figure of the pans uſed in Holland[z]. The furnace over which the pan is erected may have four mouths, made on the oppoſite ſides, at equal diſtances, for the conveniency of receiving fuel. The fire may be made on a hearth; and within the furnace muſt be

lead pans. But if of a cylindrical form, the ſcratch may be raked from its bottom, as at the Lemmington works. And if any ſalt be raked up with the ſcratch, it need not be loſt, but may be diſſolved from among it by water. Or if a conſiderable quantity of ſcratch remains mixed with the ſalt, it will with other groſs impurities ſubſide in the brine, when the ſalt is again diſſolved in water, as directed in the ſecond proceſs.

At one corner or ſide of the pan may be fixed a pipe with a cock, through which the bittern may be drawn out, when occaſion requires, and thither there may be a gentle fall from all other parts of the bottom. It is true indeed that in the common proceſſes of making ſalt, the pans are ſo ſhaken by the violent boiling that they do not long retain the ſame poſition, by which motion of the pans their joints are looſened, and their bottoms often cracked and bulged; ſo that by ſuch accidents a pipe might ſoon be rendered uſeleſs. But theſe accidents might probably be prevented by faſtening the pan down in its ſituation with ſtrong bars of iron, firmly fixed in the earth, and hooked cloſe to the corners and ſides of the pan.

[z] It may probably require a large ſalt marſh or even ſeveral ſalt marſhes, in order to keep a pan of this ſize conſtantly at work.

erected proper pillars of brick or mid-feathers; and, if occasion requires, strong posts, and cross bars of iron, to support the bottom of the salt pan. There must also be four funnels for conveying away the smoke, placed at equal distances between the mouths of the furnace. If the pan be square, the funnels may be carried up at its four corners, and the mouths may be under the middle of its four sides. The mouths must all have doors fitted to them very close; and the funnels for conveying away the smoke, must have registers; all which may be opened or shut, as occasion requires, for the more convenient regulating of the fire.

THINGS being thus prepared, let the salt pan be filled with strong brine, drawn from the cistern, and well cleared from its muddy sediment. Then, kindle the fire (pit coal will serve very well for this use, and will, in all parts of Great Britain, be much cheaper than cinders and the most parts, than any other kind of fuel) and mix a sufficient quantity of whites of eggs with the brine to clarify it from its viscous matter, and other light impurities. Let the brine at first boil gently, and when the scum hath all arisen, take it off

after the manner before directed[3]. As soon as the brine is skimmed, abate the fire, and only let a moderate heat be applied, sufficient to keep the brine of a scalding heat, which may be a heat of about two hundred degrees in Farenheight's thermometer. When the salt begins to grain, rake out the scratch, which will then be fallen to the bottom of the pan. When the brine is thus fully depurated, in order to correct its alcaline quality, a proper quantity of sour whey may be added to it, which can do no harm, and hath long been used by the Dutch with success[4]. After the whey hath been added, the brine must be kept of a scalding heat all the time that the salt is graining or forming into crystals. And when most of the salt is crystallized, and lies in the pan almost dry on its surface, the fire must be damped by shutting the doors of the furnace, and the registers; and the salt must be drawn from the liquor to the sides of the pan, and put into drabs, or other proper vessels, till all the

3 Part ii. Chap. ii. Sect. 1.

4 The alcaline salt will by this acid whey be converted into a neutral salt, resembling the Tartarus regeneratus, which will remain dissolved in the bittern.

bitter

bitter liquor is drained from it; and then it will be fit to be uſed in the ſecond proceſs of refining.

THE ſalt pan, after every ſecond or third time that this proceſs is finiſhed, muſt be emptied of the bittern; and at proper times muſt alſo be cleanſed from the ſtone ſcratch adhering to it.

THUS may be prepared a good kind of ſea ſalt, ſtronger, and of a much firmer and larger grain than any kind of common white ſalt made by the methods now in uſe. And after this manner may alſo be prepared a ſalt for the table, better in quality, and at a leſs expence than by the common methods. Only as ſuch ſalt is required of a fine grain, it may be granulated with quicker fires than here directed, and may be drawn out of the pan before it hath lain long enough to form into large cryſtals; ſo that it may be taken out at five or ſix draughts during the proceſs. The ſecond and third draughts will be the beſt ſalt, being the moſt free from ſcratch, and the ſalts of the bittern.

AFTER the ſame manner a good kind of white ſalt may be extracted from natural brine; and likewiſe from a ſolution of rock ſalt in weak brine or ſea water.

But if inſtead of ſtrong brine, ſalt water as drawn from the ſea be uſed in this proceſs, then it may be proper to have a ſalt pan of twice the capacity of the pan above deſcribed; ſo that it may be a yard in depth[5], and forty feet in diameter. The ſea water received into this pan, after it hath been clarified with whites of eggs, may be made to boil very violently[6], until one half,

[5] We are told of pans of this depth being uſed at ſome foreign ſalt works, as at Inn'thall and Roche; and ſuch are uſed in England at the copperas works. An addition made to the depth of the pan by heightening the ſides with ſtrong ſheets of lead; and alſo covering with them a rim of timber fixed round the top, may make the pan of double its former capacity, at a ſmall increaſe of coſt. What effect ſuch a weight of water may have upon the bottom of the pan, and whether it will require greater fires to boil it, or whether the evaporation will be proportionably quicker in ſuch deep pans than in ſhallower, are queſtions which may beſt be determined by experiments. Certain it is, that with ſuch pans there will be much leſs trouble in filling them up, and clarifying the brine; and alſo much leſs danger of burning the ſalt, and waſting its ſpirit, than in ſhallower pans.

[6] The violent boiling, here directed, will greatly ſhorten the proceſs, and will not much weaken or waſte the ſalt by diſſipating its acid ſpirit. For from Dr. Hale's experiments, it appears that ſcarce any of this ſpirit ariſes from boiling ſea water until more than one third of the water is evaporated. And when the ſea water hath been clarified from its viſcous matter, it is probable, from the ſame gentleman's experiments, that little

or eighteen inches depth of it, be evaporated; and then the pan may be filled up with ſea water a ſecond time, which muſt be clarified, and boiled down a foot in depth; and then filled up a third time, and clarified as before. After which the liquor muſt be evaporated to a ſtrong brine, taking care to leſſen the fire as the brine increaſes in ſtrength, and when it becomes ſo ſtrong as to contain about a fifth part of ſalt, then only to uſe a ſcalding heat; taking out the powder ſcratch when the ſalt begins to fall, correcting the alcaline quality of the brine with ſour whey, and graining the ſalt with a ſcalding heat, as before directed.

THE white ſalt being prepared according to the methods above propoſed: Then, in the ſecond proceſs of refining, take a ſufficient quantity of this white ſalt, put it into a large ciſtern made of wood, or bricks and clay; add to it as much pure river water

of this ſpirit will ariſe before half of the water is evaporated; as directed in this proceſs. But if the violent coction be continued till the ſalt begins to grain, and the brine afterwards be ſuffered to ſimmer during the whole proceſs, according to the common practice; the ſalt will be greatly diminiſhed in quantity, and weakened in ſtrength by the diſſipation of its acid ſpirit.

as will be ſufficient to reduce it to a ſtrong brine, almoſt fully ſaturated with ſalt; when the ſalt is diſſolved, let the brine ſtand quiet, and if any ſcum ariſes, take it off: A large ſediment will fall to the bottom of the ciſtern, which, when all is ſettled, the clear brine is fit for uſe.

THE ſalt pan moſt proper for working this brine is the ſame that is propoſed for preparing white ſalt from brine in the firſt proceſs. The pan will be more proper for this uſe, when its inſide is covered with a cruſt of ſcratch, than immediately after the ſaid cruſt hath been picked off it.

THE pan being carefully cleanſed from bittern, the clear ſolution of white ſalt, prepared as before directed, muſt be drawn into it, out of the ciſtern, by troughs, cranes, or pumps; care being taken that all the calcarious earth, and other impurities of the white ſalt, ſettled to the bottom of the ciſtern, do there remain undiſturbed. The fire muſt then be kindled in the furnace (pit coal will ſerve very well for this uſe) by which the watery part of the brine muſt be ſlowly evaporated; care being taken that the heat uſed be ſo mild and gentle that none of the ſaline ſpirit be ſeparated by it. The heat of the brine

brine during the whole procefs from firft to laft, muft therefore be equal and regular, and confiderably lefs than the heat of boiling water; perhaps a heat of one hundred and fixty, or one hundred and eighty degrees in Farenheight's thermometer may be the moft proper. A little experience will fhew the greateft heat that falt can endure without any diffipation of its acid fpirit; and that is the heat here propofed to be ufed. The expert artift, by means of the regifters in the chimneys, and the doors of the furnaces, may fo regulate the fire, as to keep the brine coftantly heated to a certain degree of the thermometer, if fuch exactnefs fhould be required.

WHEN the evaporation is fo far advanced that little faline cryftals begin to appear on the furface of the brine, then may be added thereto a fufficient quantity of the acid muriatic fpirit, fo that neither the acid nor the alcaline principle of the falt may remain predominant[7]. Which being done, the eva-

[7] The quantity of acid fpirit here propofed to be added may be exactly determined by proper affays; for if it be found by experiments that a gallon of the brine requires one, two, or three drops of the fpirit to faturate it; from thence may be known the quantity required to faturate all the brine contained in the pan.

poration muſt be continued until ſo much ſalt is formed in the pan that its ſurface is almoſt dry. The doors of the furnace and regiſters muſt then be cloſed, and the fire ſmothered out; and the ſalt, which will be found in large clear cryſtals, muſt be raked to the ſides of the pan, and, when it hath drained there a little time, muſt be taken out and put into drabs or other proper veſſels to drain further from the ſuperfluous brine, and then will be fit for ſale.

The ſtrong brine which remains in the pan after the refined ſalt is drawn out, and the brine that drains from it, ought not to be mixed with the ſolution intended to be made into refined ſalt; but will ſerve to mix with the brine to be boiled up in the firſt proceſs into common white ſalt.

The ſalt refined after the foregoing proceſs will be exceeding ſtrong and pure, and will have all the qualities required in ſuch ſalt as is moſt proper for preſerving fiſh, fleſh, and other proviſions.

For firſt this ſalt will be extremely well depurated from all earthy alcaline ſubſtances, and from all the ſalts of the bittern, and all other mixtures of a different nature from it. So that in purity it will greatly exceed bay

ſalt,

ſalt, and even the Dutch refined ſalt, which they do not refine with pure river water, but with ſea water, which abounds with calcarious earth, and bitter ſalts, as hath before been demonſtrated.

SECONDLY, the ſalt thus prepared will be extremely ſtrong, and fully ſatiated with its acid ſpirit. For the white ſalt propoſed to be thus refined, is a ſtronger kind than any now commonly made. But ſhould a much weaker kind be uſed, which had been deprived of a conſiderable quantity of its acid ſpirit, even from this weak ſalt a ſtrong pure ſalt may be prepared after the manner propoſed in the ſecond proceſs. For the ſaline particles deprived of their acid, as they are not a perfect muriatic ſalt, cannot therefore form into cubic cryſtals, but will either ſubſide in the brine, in a white powder, or elſe, after the proceſs is finiſhed, will remain in the mother brine or bittern in the form of an alcaline ſalt; ſo that only the ſtrong pure cryſtals of ſalt will be reduced into a ſolid form in the ſecond proceſs; but in the ſecond proceſs, here recommended, care is taken again to reſtore to thoſe alcaline particles, the acid ſpirit of which they had before been deprived, and with it to convert them

them into a perfect muriatic salt. And the heat wherewith it is proposed to evaporate the water from the brine, being mild and well regulated, none of the acid spirit will again be wasted. The salt therefore refined according to the method here proposed, may well be esteemed a purer and stronger salt than that refined by the Hollanders, and at least equally excellent for preserving provisions. So that it will fully answer all the requisites in the foregoing problem.

As to those additions which many recommend in order to make the salt grain or crystallize better, and to render it of a firmer and harder texture, they seem in this process entirely superfluous, and would prove prejudicial rather than serviceable, by rendering the salt impure. For when the watery vapours exhale from the brine, by a mild and gentle heat, the salt naturally forms into large hard crystals without any addition, as may be observed in the preparation of bay salt.

In the above process for refining white salt, the most exact methods are described; although in practice such great accuracy may probably not be required: So that instead of the strong white salt prepared according

to

to the firſt proceſs, a weaker kind, boiled with more violent fires, may probably be ſubſtituted without any damage; and inſtead of pure river water propoſed in the ſecond proceſs for diſſolving the ſalt, ſea water may be ſubſtituted, agreeably to the practice of the Dutch, and then a conſiderable part of the expence will be ſaved. There are even ſome kinds of natural brine ſo free from ſcratch, bitter ſalts, and other impurities, that, after they are depurated from their ſediment, and properly clarified, may probably, by the method propoſed in the ſecond proceſs, be reduced into a pure ſtrong ſalt, fit to be uſed as a condiment without undergoing the previous operation of boiling into white ſalt; ſuch, probably, may be the excellent brine of Droitwich.

AND although the brine of Cheſhire, and alſo the rock ſalt of that county, contain much ſcratch and other impurities, inſomuch that the Dutch have found by experience, that the latter cannot, by their method, be refined into ſo ſtrong and pure a ſalt, as that which they prepare from marine bay ſalt; yet there is great reaſon to believe, that, if the muriatic ſpirit before recommended be rightly

rightly applied and other proper means be uſed, a ſtrong and pure white ſalt may be prepared, at one proceſs, not only from Engliſh rock ſalt, and moſt kinds of Engliſh brine, but alſo from ſea water, which will be very fit for curing proviſions, in all the different ways, and for all uſes. For ſo great is the efficacy of this ſpirit, that by a proper mixture thereof, even common white ſalt may, in caſes of neceſſity, be made to ſerve for curing beef for long voyages; as I have reaſon to conclude from my own experiments, as well as from others, with which I have been made acquainted.

PROP. II.

In ſeveral parts of Great Britain, white ſalt might be refined by the foregoing method, at a ſmall expence, and in any quantity wanted.

It is a happineſs to Great Britain to be ſurrounded with ſeas, which, beſides other advantages drawn from them, may be made to yield an inexhauſtible ſtore of ſalt. This iſland likewiſe abounds in rock ſalt, and natural brine; from all which refined ſalt may be

be prepared in any quantities that can poſſibly be wanted, either for home conſumption, or for exportation abroad.

MOREOVER, it is a bleſſing peculiar to this iſland, to have vaſt mines of foſſil coal in many places, nigh the ſea, and nigh ſalt ſprings and mines of rock ſalt; with which coal, ſalt might be refined much cheaper here than in moſt other countries.

IN many parts of Great Britain, as at Shields, pit-coals are ſo cheap, that ſalt boiled with them from ſea water, can be afforded at ſo ſmall a price as eight pence per buſhel; and might, no doubt, be afforded at ſuch places, for half the money, if, inſtead of boiling ſea water into ſalt, they uſed the ſame water firſt heightened into brine by the ſun and air, after the method here propoſed; and if, inſtead of pans holding about 1800 gallons, they uſed pans like thoſe of the Dutch, holding nigh ten times that quantity.

THE ſalt boilers at Lemington who heighten ſea water into brine (by a method not the moſt commodious) uſe chiefly Newcaſtle coals in boiling their ſalt, and pay five or ſix times the price for them that is paid at Newcaſtle or Shields. But in making a certain

certain quantity of ſalt, they only evaporate one gallon of water by fire, for eight or ten gallons evaporated by the ſalt boilers at Shields; and with a pan of the ſame magnitude, and the ſame quantity of coals uſed at Shields, can make at leaſt five or ſix times the quantity of ſalt that is made at the latter place; by which means they are able to ſell their ſalt at the London market, even cheaper than the ſalt boilers of Shields. From whence appears the great profit of heightening the ſea water into brine, by the force of the ſun and air.

THE great advantage of uſing large pans like thoſe of the Dutch will alſo appear, by conſidering, that a large furnace will require leſs fuel in proportion to its magnitude to heat it to a certain degree, than is required in a ſmaller one; and that two lobourers, who are now employed in working two ſalt pans of the common ſize uſed at Shields, which hold each about 1800 gallons, will, with greater eaſe, work a large pan, of the ſize above propoſed, holding about ten times that quantity; ſo that the price of labour and fuel (which are the articles of the greateſt expence) will be much leſs in the

larger

larger work than in the ſmaller, in proportion to the quantity of ſalt made in each.

THE Dutch, in refining ſalt for the table, work out one of their large pans of brine every twenty-four hours; and if, from each gallon (wine meaſure) of the brine uſed, two pounds and an half of ſalt be extracted; then, in a pan whoſe bottom is forty feet ſquare, and depth eighteen inches, they uſually make 801 buſhels of table ſalt every twenty-four hours[1]. And the ſame quantity of ſalt might be made from brine of equal ſtrength, in an equal time, whether the brine be a ſolution of coarſe bay ſalt, as uſed by the Dutch, or ſea water heightened by the ſun, after the manner before propoſed. But, as in the firſt proceſs before deſcribed, it is propoſed to evaporate the brine with a very gentle heat, in order that the ſalt may be very ſtrong; we ſhall therefore ſuppoſe only ſix inches depth of brine to be evaporated every twenty-four hours, and then the whole proceſs will take up three days;

[1] Suppoſing the pan to be filled quite to the brim; but if the pan ſhould not be quite filled, they may notwithſtanding make this quantity of ſalt every twenty-four hours, by uſing a ſtronger brine than here ſuppoſed.

and

and ſuch gentle fires will be applied, that probably not much more fuel will be conſumed in thoſe three days, than is conſumed in the ſame time, in boiling ſea water with violent fires in the common Newcaſtle ſalt pans, which hold about 1800 gallons. Although in the large pan 801 buſhels of ſtrong ſalt will be made in three days; and only about 60 buſhels of a weaker ſalt in the ſmall pan, by the method now in uſe, as I have been aſſured by very good judges.

But if, in working the large pan, according to the method here propoſed, it ſhould be granted, that even twice as many coals were conſumed as would work a Newcaſtle ſalt pan of the ordinary ſize, with violent fires, which is certainly a very large allowance; then, as many coals would be conſumed in three days, in working the large pan, as would make 120 buſhels, or three tuns of ſalt, according to the method now practiſed about Newcaſtle. And, allowing three chaldrons of coals to make a tun of ſalt, after the method there practiſed, agreeable to the eſtimates of ſome of their moſt experienced ſalt boilers; then nine chaldrons of coals (which at Newcaſtle are ſold for 2 l. 9 s. 6 d.) would, by the method here

here propoſed make from brine 801 buſhels or twenty tuns of ſalt. So that the expence of coals (where they can be had ſo cheap as at Newcaſtle) would not exceed 2s. 6d. for every tun of ſalt thus prepared. Although, in making white ſalt after the common methods, fuel is the moſt expenſive article; and at Newcaſtle, where coals are ſo cheap, coſts above half the price of the ſalt prepared with it.

THE ſame calculations alſo ſhew the extraordinary advantages of making white ſalt from natural brine, or rock ſalt in large pans, according to the method here propoſed.

BUT if ſea water be boiled down to white ſalt without any previous preparation, after the method before propoſed; then, in a large ſquare pan, ſuch as is directed for that uſe, 65828 gallons of water will be evaporated at each proceſs, from which may be obtained 235 buſhels of ſalt, allowing a pound of ſalt to be extracted from forty pints of the water.

I AM very far from impoſing the above calculations upon the public for ſuch as will be found exactly true in practice; being ſenſible that true eſtimates of the expence of

preparing white ſalt by the methods here propoſed, can only be made from proper experiments. Although theſe calculations ſufficiently prove, that a ſtrong white ſalt may be made by the propoſed methods conſiderably cheaper, than a weaker ſalt is made by the methods now in uſe; and very probably might be afforded for half the price for which white ſalt is now uſually ſold.

If this ſhould be found true by experience; then, as it would probably coſt little more to refine the white ſalt than to make it from brine or ſea water; white ſalt refined after the method before directed might therefore probably be afforded for the ſame price now uſually paid for common white ſalt, viz. from ſix pence to ten pence per buſhel.

But as it may be neceſſary to ſet this matter in a clearer light; let it be ſuppoſed that the white ſalt uſed in refining, coſts eight pence per buſhel, which is about the wholeſale price of the ſalt made at Shields. In this eight pence is therefore included the price of coals, labour, a proper conſideration for the houſes, veſſels, aud other utenſils employed in preparing this buſhel of

ſalt;

ſalt; and alſo the profit of the owner of the work. But as it is found by experience, that forty pounds of ſea water is commonly evaporated for each pound of ſalt obtained, therefore in making a buſhel or fifty-ſix pounds of ſalt $56 \times 40 = 2240$ pounds, or about 280 gallons of water may be ſuppoſed to be evaporated. But 280 gallons of water will very well diſſolve twelve buſhels of ſalt, allowing leſs than two pounds and an half of ſalt to a gallon of water. So that twelve buſhels of ſalt may be refined, by evaporating the ſame quantity of water that is commonly evaporated in boiling one buſhel of ſalt from ſea water. And if a proper apparatus be uſed, ſuch as before deſcribed, the expence of evaporating this quantity of water from the refined ſalt, will not probably exceed the expence of evaporating it from the boiled ſalt, according to the preſent method. But allowing the expence of evaporating the ſaid quantity of water from the refined ſalt, to be treble the expence of evaporating it from the common boiled ſalt; allowing alſo the droſs and impurities of the boiled ſalt, together with that which is loſt of it in refining, to be a twelfth part of the whole; ſo that from twelve buſhels of

the common boiled ſalt, only eleven buſhels of refined ſalt can be obtained; then the price of eleven buſhels of refined ſalt will be as follows:

	l.	s.	d.
To twelve buſhels of common white ſalt at 8d. per buſhel	0	8	0
To the expence of evaporating 280 gallons of water, and other expences of refining the ſaid ſalt; being treble the expences of evaporating the ſame quantity of water, and of the other expences attending the preparation of a buſhel of white ſea ſalt, after the common method	0	2	0
So that 11 buſhels of refined ſalt will coſt	0	10	0

Which is nearly eleven pence per buſhel, and the expence of refining will be ſomewhat leſs than three pence per buſhel.

BUT if, inſtead of ſea ſalt, boiled rock ſalt, or brine ſalt be uſed, which can now be afforded in Cheſhire for ſix pence per buſhel; then the eſtimate will ſtand thus:

To

	l.	s.	d.
To 12 bushels of boiled rock, or brine salt	0	6	0
Charges of refining	0	2	0
And the price of eleven bushels of refined salt will be	0	8	0

Which is 8d. $\frac{8}{11}$, or nearly 8d. $\frac{3}{4}$ per bushel.

BUT if white salt prepared by the method recommended under proposition the first be used, which in several parts of Great Britain may probably be afforded for four pence per bushel; then, according to the above estimates, the refined salt will cost the refiner about six pence halfpenny per bushel, who may therefore very well afford to sell it for eight pence per bushel.

THE following estimate brings the matter a little nearer to practice, and therefore to some may seem more clear and satisfactory than the foregoing.

THE Dutch salt pan of a cylindrical form, forty feet in diameter, and eighteen inches deep, will contain 14106 gallons, wine measure. Supposing therefore, that into a pan of that size 14000 gallons of brine be poured, of such a strength, that from each gallon

lon two pounds and an half averdupoize of ſalt may be extracted. From the whole 14000 gallons of brine, then may be extracted 35000 pounds or 625 buſhels of ſalt. So that 625 buſhels of refined ſalt may eaſily be prepared in ſuch a pan in ſix days (the Dutch perform this operation in three days) allowing only three inches depth of water to exhale every twenty-four hours. And if the whole proceſs be conſidered, the labour and attendance required in working ſuch a pan will not appear greater, than is required in working a common Newcaſtle pan, in boiling ſea water into ſalt. And, as very ſtrong fires are uſed in boiling ſea water, as many coals will probably be conſumed in keeping ſuch a common pan conſtantly at work, as in keeping the brine in the large Dutch pan of a mild and temperate heat. It therefore ſeems highly probable, that the expence of fuel and labour will be as great in working a common pan in boiling ſea ſalt, as in working a pan of the above dimenſions in refining ſalt.

But in a common pan about 120 buſhels of ſalt may be boiled from ſea water in ſix days, the price of which at eight pence per buſhel is four pounds; in which four pounds

pounds is not only included the price of labour and coals, but alſo a proper allowance for the wear of veſſels and utenſils, and for all other contingent expences, together with the profit of the owner of the work. But ſuppoſing the expence of labour and fires only, in the propoſed work for refining ſalt, to amount in ſix days to four pounds; and allowing three pounds more for the wear of veſſels and utenſils, and other contingent expences, and the refiners profit; and alſo eighteen ſhillings more for fifty-four buſhels of white ſalt, which may be ſuppoſed to be waſted in the proceſs. Then the whole expence of the work for ſix days (the profit of the owner included) will amount to ſeven pounds eighteen ſhillings; which being charged upon 625 buſhels of ſalt, in that time refined, amounts to very little more than three pence per buſhel.

As in the above calculations large allowances are made in every article; it therefore ſeems probable, that ſalt refined in the foregoing manner, may in ſeveral parts of Great Britain be afforded for ſo ſmall a price as eight pence per buſhel. But ſhould we even ſuppoſe the unrefined white ſalt to

coſt eight pence per buſhel; and inſtead of three pence per buſhel, the price of refining as before eſtimated, ſhould allow thrice that ſum, or nine pence per buſhel for refining it; then the price of a buſhel of this refined, ſalt would be ſeventeen pence, which is leſs than the Dutch pay for their ſtrong refined ſalt; and is leſs than half the ſum now uſually paid in London for bay ſalt, for curing proviſions. For in times of peace, the beſt bay ſalt commonly there coſts the conſumer about ten ſhillings per buſhel, weighing eighty-ſix pounds; and now, in time of war, eleven ſhillings per buſhel; which, abſtracted from the duty, is two ſhillings and ten pence two thirds for fifty-ſix pounds; the weight of a buſhel of white ſalt. So that if the Britiſh refiner can afford his ſalt at the market for leſs than two ſhillings and ten pence two thirds per buſhel, large ſums of money may be ſaved in the nation, which are now paid for foreign ſalt, and ſerve to enrich our enemies and rivals in trade.

All theſe calculations are made without any regard had to the ſalt duties; upon a ſuppoſition that the ſalt is ſold duty free, as that is which is exported abroad, or uſed in curing fiſh for foreign conſumption. But

if the duties, as now regulated by law, are alſo taken into conſideration, the Britiſh refiner of white ſalt, hath greatly the advantage over the importer of foreign ſalt, as will appear from the accounts already given of the duties upon each.

FROM all the above-mentioned facts and reaſonings we may therefore conclude, that white ſalt refined after the foregoing method, (probably better in quality, and fitter for the uſe of the fiſheries, and for curing all kinds of proviſions, than French, and other impure kinds of bay ſalt) might eaſily be prepared in Great Britain, in any quantity wanted, and might be there afforded conſiderably cheaper than foreign bay ſalt; ſo that the money paid to foreigners for ſalt might eaſily be ſaved in the kingdom, and great advantages might ariſe from uſing this ſalt (or pure bay ſalt prepared as before directed) in the Britiſh fiſheries; and by means thereof, the Britiſh colonies in the Weſt Indies, and the navies and commerce of Great Britain, might be put out of a ſtate of dependance upon its enemies for one of thoſe neceſſaries without which they cannot poſſibly ſubſiſt.

AND now it may be proper to conclude this treatiſe with obſerving, that moſt of the facts referred to in the courſe of theſe diſquiſitions, are ſuch, as the conſtant practiſe of thoſe who make ſalt ſufficiently warrants us to rely upon for true and certain; or elſe, they are the obſervations of judicious ſalt officers, daily converſant in theſe matters; or, of curious and inquiſitive navigators, merchants, travellers, and naturaliſts; or laſtly, the experiments of many learned phyſicians, chemiſts, and philoſophers; the truth of which ſeveral facts, though many of them have long been publiſhed, hath never to my knowledge been called in queſtion. So that theſe obſervations and experiments may probably be more relied upon by the public, than if they had only been made by myſelf; ſince they have the teſtimony of many ſkilful and unprejudiced perſons, who could have no notion of the uſes to which they have been here applied. If therefore the arguments founded upon thoſe facts ſhould be eſteemed any ways reaſonable and ſatisfactory, I humbly preſume to remark, that it might not be unworthy the wiſdom of the Britiſh legiſlature to direct a more full inquiry to be made into a matter of this importance;

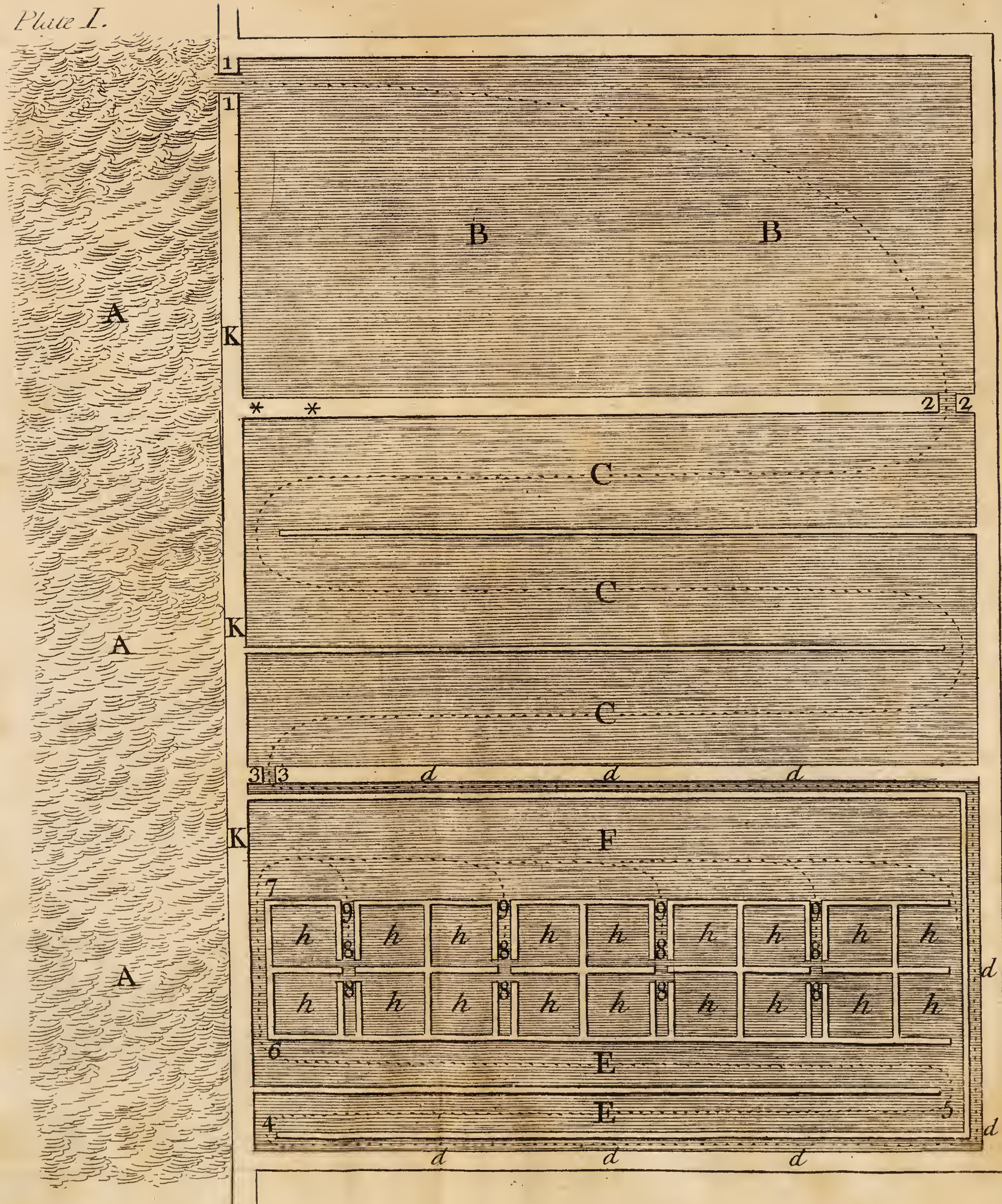
portance; and to order proper works to be erected for making bay ſalt, and for making and refining white ſalt; and to put thoſe works under the management of able and judicious perſons, to make exact and accurate tryals, in order to diſcover the beſt and cheapeſt methods of making bay ſalt, and of making and refining all kinds of white ſalt. And the methods which ſhould be moſt approved of, might for the general good, be made public, and eſtabliſhed by law, as a common ſtandard, to which all thoſe who make ſalt in the Britiſh dominions ſhould be obliged to conform. And it would be the intereſt of the proprietors of ſalt works ſtrictly to comply with the rules ſo eſtabliſhed; but if they ſhould neglect them, the exact obſervance of them might, with the greateſt eaſe be enforced; ſince his Majeſty hath officers who conſtantly attend at all ſalt works, who are commonly well ſkilled in the buſineſs of making ſalt, and might eaſily be made acquainted with the rules eſtabliſhed, and with the qualities required in the ſeveral kinds of ſalt, and might have orders to inſpect over the preparation of ſalt, and to receive none into the king's warehouſes, but ſuch as was fit for

 ſale,

fale, and duly prepared according to the ftatute; and might have power to feize, and (with the aid of the civil magiftrate) to condemn and deftroy all falt not rightly prepared, or at leaft to take care, that it was only applied to the improvement of land, and fuch like purpofes. Such an eftablifhment would put it out of the power of any one to impofe bad falt upon the publick, as is now too frequently done, in a moft fcanlous manner, to the great damage of thofe who ufe fuch bad falt for curing provifions, and to the great prejudice of the health of many of his Majefty's fubjects, who are often obliged to live upon provifions thus fadly cured. By fuch an eftablifhment alfo, the falt officers might be made to do a very confiderable benefit to the nation, with little additional trouble to themfelves, and his majefty's fubjects would have reafon to efteem the duties upon falt lefs burthenfome than at prefent, if by this means they were affured of being conftantly fupplied with fuch falt as was moft fit and proper for the feveral purpofes for which it was defigned.

Expla-

Plate I.



Explanation of the Plates.

PLATE I.

A A A. Is the ſea.

1 1. The entry, by which the ſea-water paſſes into B B.

B B. The firſt receptacle; in which the water is kept twenty inches deep.

C C C. The ſecond receptacle, where the water maketh three turnings, as you ſee, and is ten inches deep.

* * The place, where the communication between the firſt and ſecond receptacle is made in the French ſalt marſh, but here more conveniently removed to 2 2.

2 2. The opening, by which the firſt and ſecond receptacle have communication one with another.

E E F. The third receptacle, which is properly called the Mariſh.

dddddd. Is a channel very narrow, through which the water muſt paſs before it enters out of the ſecond receptacle into the third.

33. Is the opening, by which the water runs out of the ſecond into the third receptacle.

The pricks, you ſee in the water throughout the whole ſcheme, mark the courſe and turnings, which the water is forced to make before it comes to *hhhhh*, which are the places where the ſalt is made.

hhhhh. Are the beds of the mariſh, where the ſalt is made; and in them the water muſt not be above an inch and an half deep. Each of theſe beds is fifteen feet long and fourteen feet large.

99999. Are the little channels between the beds.

88888. Are the apertures, by which the beds receive the ſea-water after many windings and turnings.

Plate II.

Fig. 1.

Fig. 2.

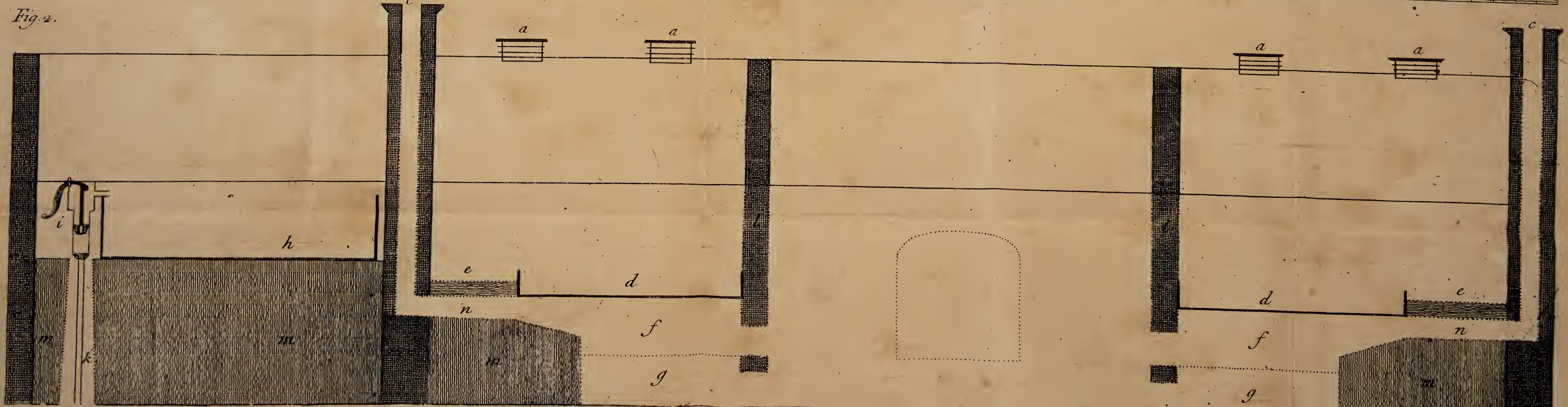


PLATE II.

Fig. I. Being a repreſentation of a marine ſaltern, with two boiling houſes, and the forehouſe in the middle between them.

a a a. L'oeuvres for the vapours which ariſe from the ſalt pan.

b b. Windows in the roof.

c c. Chimnies for the ſmoke of the furnaces.

P. Roof of tile or ſlate over the forehouſe.

Q Q. Roofs of boards over the boiling houſes.

Fig. II. A ſection of the ſaid ſaltern made lengthways; together with a ſection of a ſhed placed at the end of it with a ciſtern for the ſea-water.

a a. L'oeuvres at the top of the boiling houſes for the ſteam.

c c. The chimnies.

d d. The ſalt pans.

e e. Walks at the end of each ſalt pan.

f f. The furnaces under the ſalt pans.

g g. The aſh pits.

h h. The wood ciſtern for the ſalt-water, which is from it conveyed through pipes into the ſalt pans.

j. The pump, by which the ſalt water is raiſed into the ciſtern, from

k. The well, ſunk conſiderably deeper than the bottom of the ſaltern to the level of the ſea at half flood.

l l. The partition walls between the fore-houſe and the boiling houſes.

m m. Solid beds of earth.

n. The flues of the furnaces.

N. B. The pricked lines in the middle of the forehouſe ſhew the ſituation of the door, from which there is a deſcent by an inclined plane to the bottom of the ſaltern.

PLATE

Plate III.

Fig. 1.

Fig. 2.

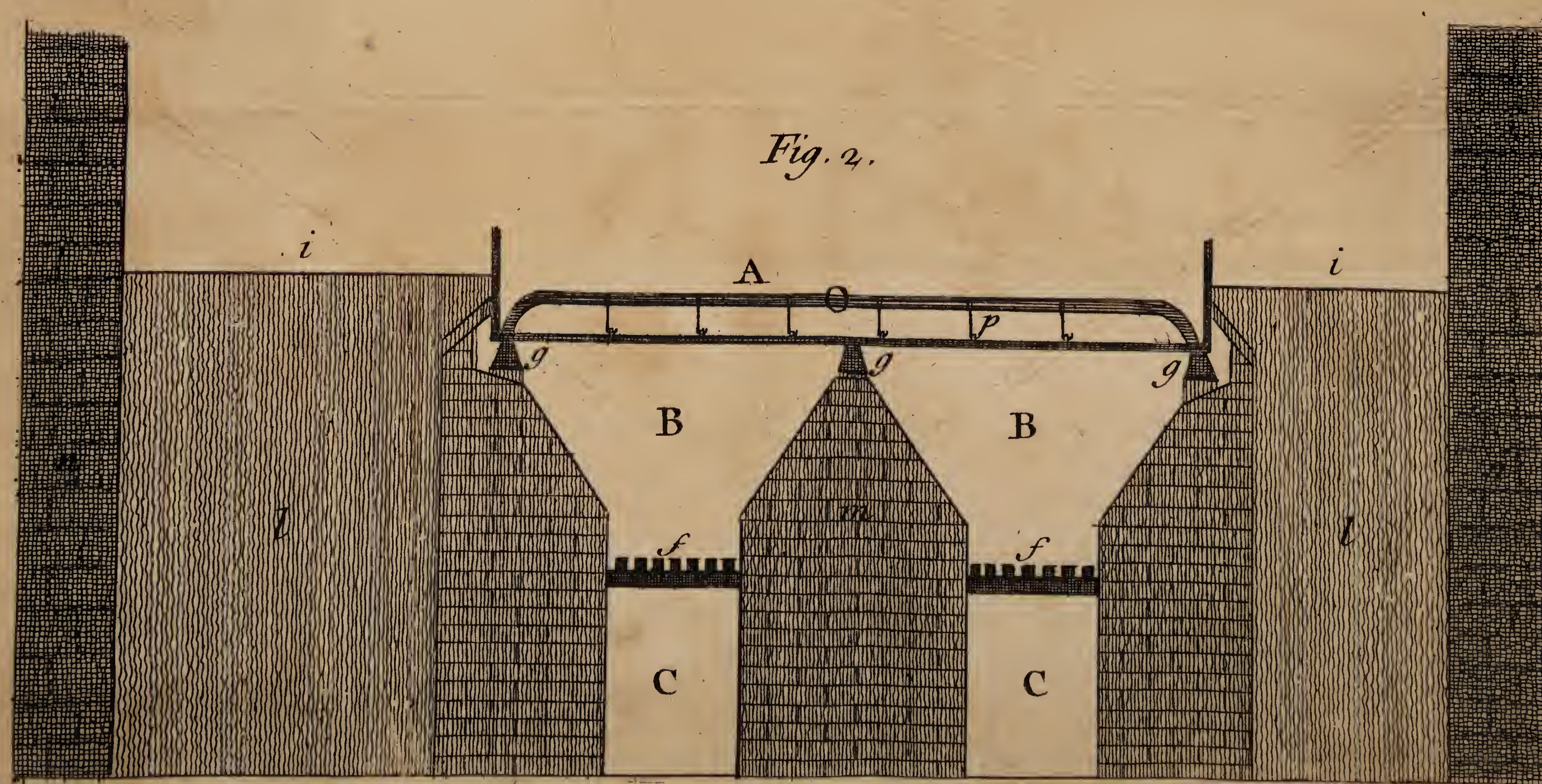


PLATE III.

Fig. I. A croſs ſection of the marine ſaltern exhibiting the front of the furnace.

a a. The doors of the two chambers of the furnace.

b b. The aſh pits.

c c. The partition wall dividing the fore-houſe from the boiling houſe.

d d d. A brick arch which ſupports the partition wall when it is neceſſary to take away the lower part and repair the furnace.

e e. Stairs leading to the boiling houſe.

f. Door of the boiling houſe.

g g. Out walls and roof of the building.

Fig. II. A croſs ſection of the furnace and ſalt pan.

A. The ſalt pan.

O. A croſs beam of iron which ſerves to ſupport the bottom of the pan by means of claſps and hooks.

B B. The two chambers of the furnace.

C C. The aſh pits.

M. The mid-feather, dividing the body of the furnace into two chambers.

f f. The grates in which are ſeen the long bars of iron, and below them the croſs bars

bars or bearers, by which the others are ſupported.

g g. Pillars of caſt iron called taplins which ſupport the ſalt pan.

j j. Walks on the ſides of the pan, that on the ſide next the door to which they draw the ſalt being broader than the walk on the other ſide.

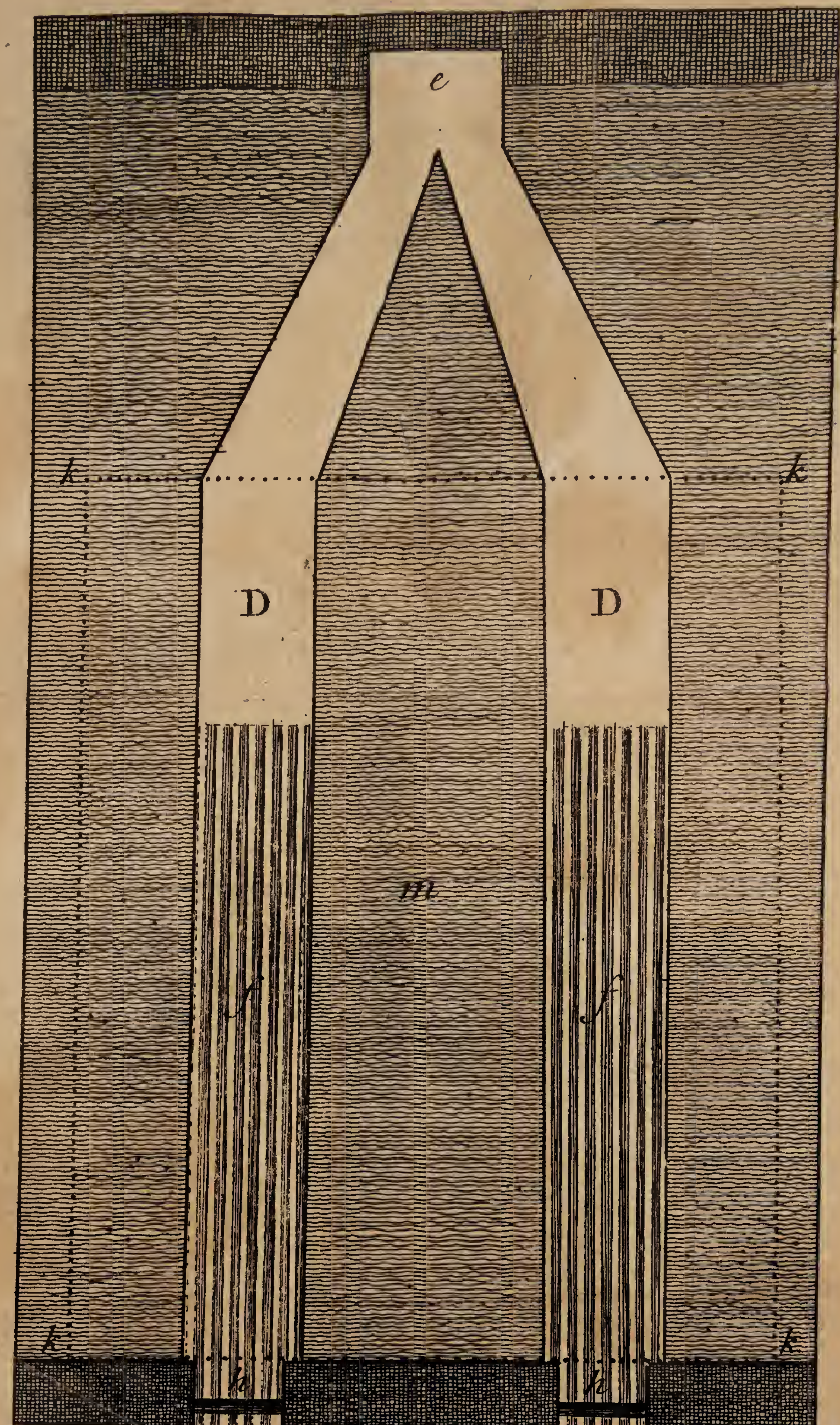
l l. Beds of ſolid earth.

n n. The out walls of the ſaltern.

PLATE

Plate IV.

Fig. 1.



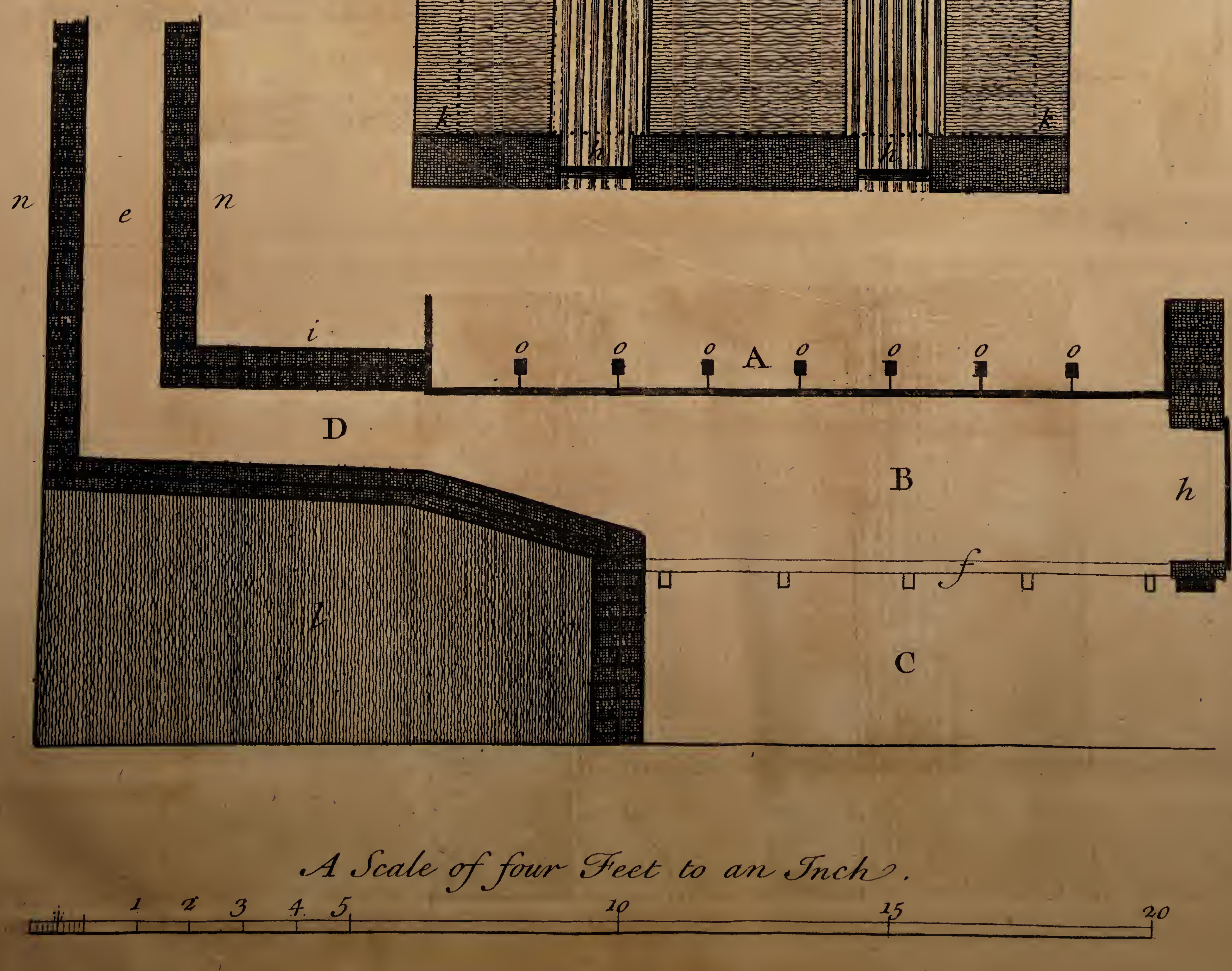


Fig. 2.

A Scale of four Feet to an Inch.

PLATE IV.

Fig. I. A plan of the bottom of the furnace with the grates, flues, &c.

f f. The grates as in the preceding figure.

D D. The flues from which the ſmoke paſſes into the chimney.

e. The entrance into the chimney.

h h. The two mouths of the furnace.

m. The mid-feather.

kkkk. Theſe pricked lines ſhew the dimenſions of the bottom of the ſalt pan.

Fig. II. A ſection of the furnace made length ways.

N. B. The letters ſhew the ſame parts of the work as in the preceding ſections. viz.

A. The ſalt pan.

o o. The iron beams which ſupport its bottom.

B. A chamber of the furnace.

C. One of the aſh pits.

D. One of the flues.

e. The chimney.

f. The grate.

h: A mouth of the furnace with

k. Its door.

j. Walk at the end of the ſalt pan.

l. Bed of ſolid earth.

n n.

n n. The partition wall and walls of the chimney.

N. B. The figures in this and the forego-ing plate are all made by one ſcale, which is given at the bottom of this plate.

PLATE

Plate V.

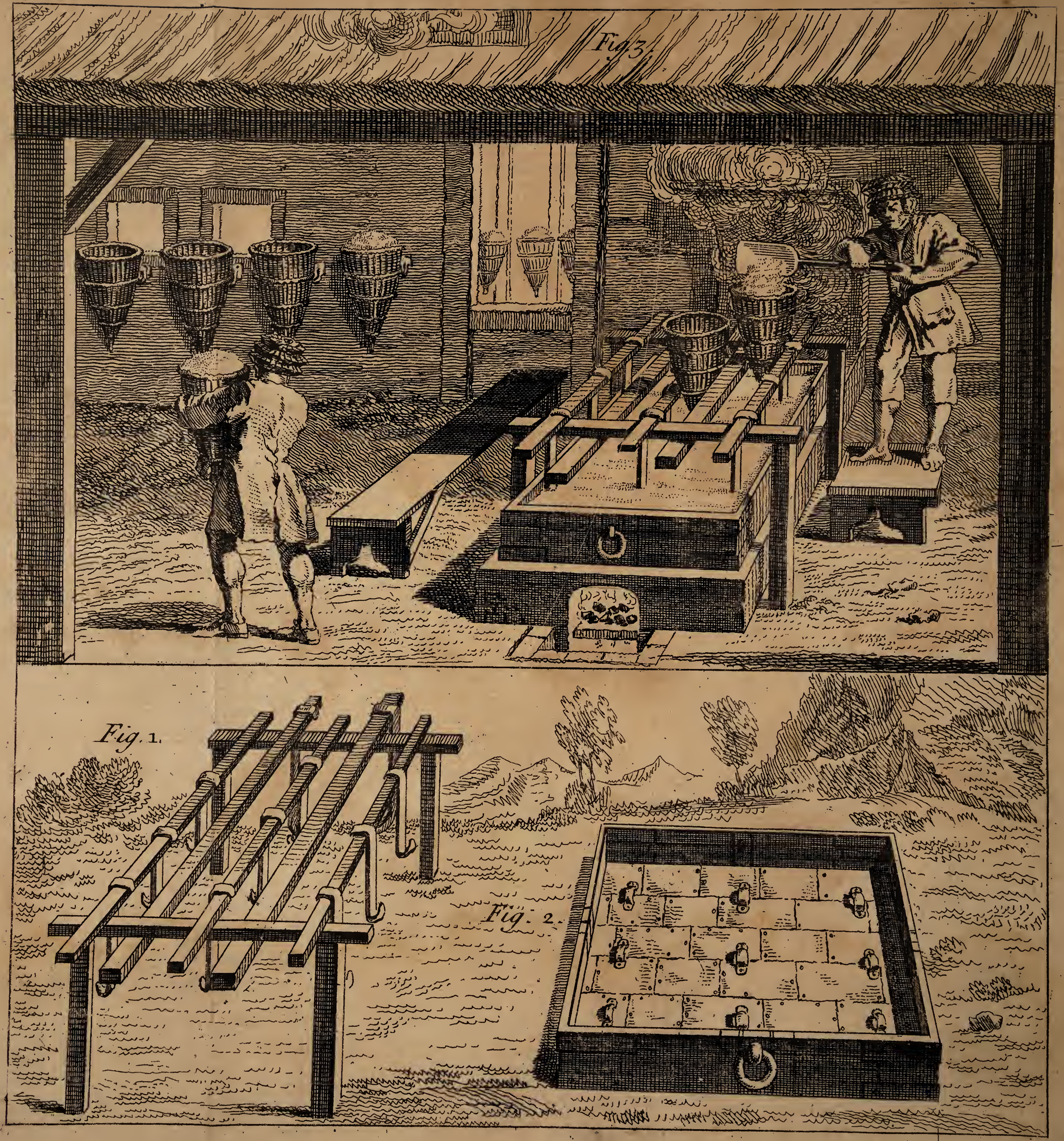


PLATE V.

From Agricola, *De re metallica*, Lib. xii.

Fig. I. Four poſts of wood fixed perpendicular in the earth; on which are erected two end beams, and ſeveral croſs beams, from which hang down hooks, ſupporting the bottom of the ſalt pan when fixed thereto by claſps. Theſe are ſtill uſed in Germany; as they were lately at ſeveral ſalterns in England.

Fig. II. A ſalt pan of iron plates with claſps fixed to its bottom.

Fig. III. The ſame ſalt-pan placed over the furnace, and ſupported by the wood beams, with the operators taking out the ſalt into baſkets, which in this work are hung up againſt the wall.

N. B. In theſe works there ſeems to have been no wall between the forehouſe and boiling houſe; and the ſalt pan ſeems to have been expoſed to the duſt and ſmoke of the furnace; ſo that when they uſed ſtraw for fuel, its light aſhes flying about made the ſalt black.

PLATE

PLATE VI.

Fig. I. The ſalt pans formerly uſed in Cheſhire four to a furnace; together with their furnace, and the hot houſe or ſtove behind them. From the Acts of the Royal Society. In which,

a a a a. The hothouſe between the wall and the chimney.

b b. Two tunnels.

C C. The chimney back into which the tunnels convey the ſmoke.

d d d d. The four pans.

E. The partition wall between the pans and the hot-houſe.

f f. The fire-places.

g g. The aſh-holes.

h. The hearth below.

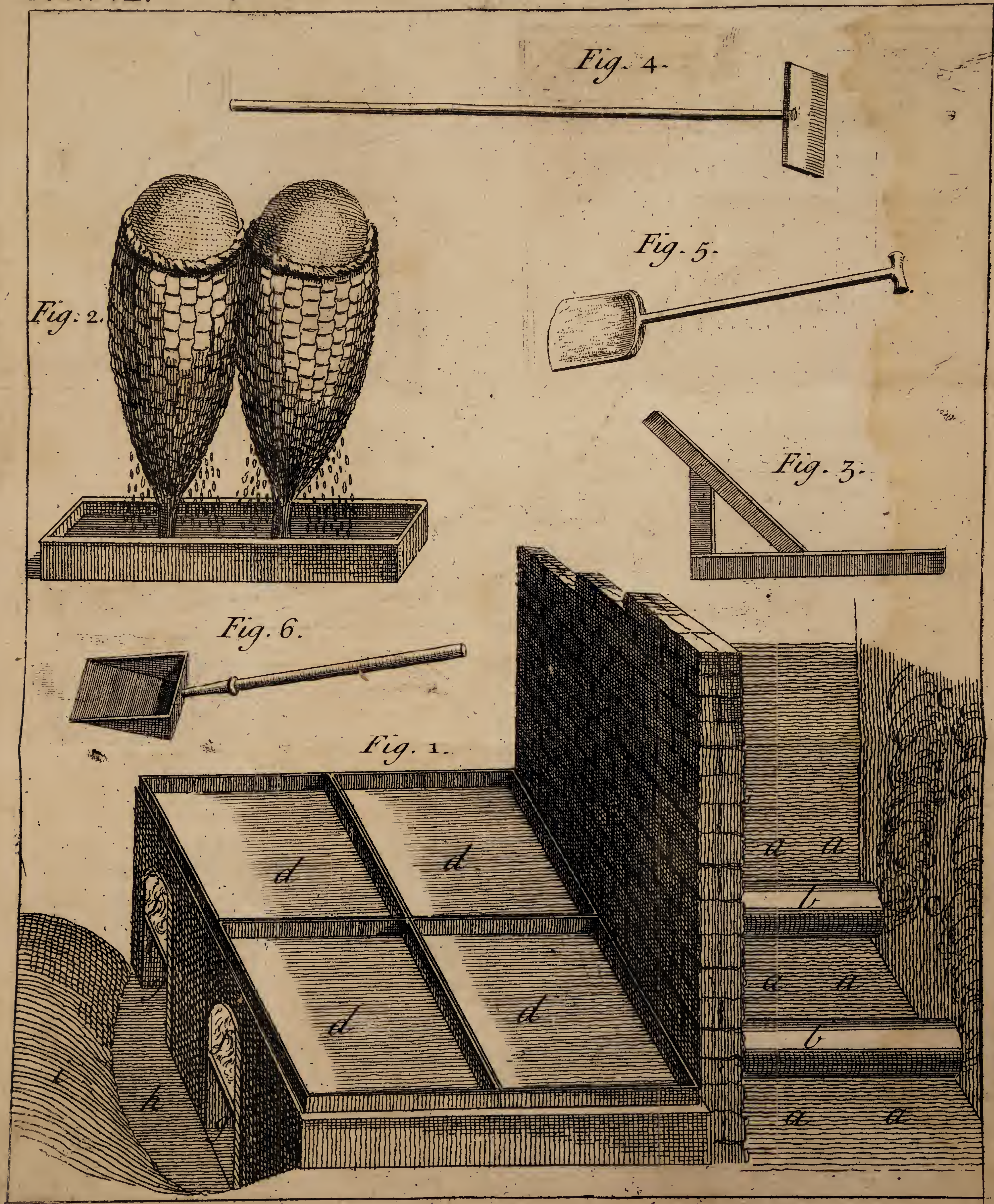
i. The deſcent to the hearth.

Fig 2. Two wicker baſkets or barrows filled with ſalt and placed over the leach trough, as practiſed at the Cheſhire ſalt works; From the ſaid acts.

Fig: 3. A ſkimmer made of boards, more commodious than the Cheſhire loot, or any other inſtrument yet invented for ſkimming the brine.

Fig. 4. The Dutch wooden rake, its han-

Plate VI.



dle twenty feet long, being preferable to the iron rakes commonly ufed for drawing the falt, as they are apt to contract ruft.

Fig. 5. A wood fhovel, to take the falt out of the pan after it is drawn to one fide with the rake.

Fig. 6. An iron ladle to take out the bittern.

F I N I S.

E R R A T A.

Pag.	Not.	Lin.		
43	- - -	7	*for* and from	*read* from
53	10		*for* Plate V. Fig. 2.	*read* Plate V. Fig. 1 and 2.
56	- -	3	*for* back ſide of the foreſide of the fore houſe	*read* back ſide of the fore houſe
61	17	10	*for* better	*read* bitter
84	14	7	*read* Boſphorus of Thrace.	
84	14	10	*for* Riv.	*read* Rio.
85	- -	4	*for* $\frac{1}{19}$ 2	*read* $\frac{1}{19.2}$
85	- -	7	*for* $\frac{1}{27}$ 3	*read* $\frac{1}{27.3}$
90	22	4	*for* putrify	*read* purify
158	1	1	*for* a whole	*read* for a whole day
182	- -	7	*for* as to	*read* as
189	- -	18	*for* 73 ^{4}	*read* 73 $\frac{4}{5}$
192	3	4	*for* $\frac{1}{28}$, 1	*read* 2 $\frac{1}{8}$: 1
224	4	4	*for* this off	*read* flies off
257	- -	22	*for* the moſt	*read* in moſt
284	- -	15	*for* ſadly	*read* badly